

SPACE

1st Quarter; Module 1

PERIOD 1

Gravitational Acceleration "g" &
Weight as a Force

H S C P H Y S I C S																		
SPACE				MOTORS and GENERATORS					From IDEAS to IMPLEMENTATION									
1	2	3	4	1	2	3	4	5	1	2	3	4	1	2	3	4	5	6



The Earth has a gravitational field that exerts a force on objects both on it and around it

Students learn to:

- define weight as the force on an object due to a gravitational field
- explain that a change in gravitational potential energy is related to work done
- define gravitational potential energy as the work done to move an object from a very large distance away to a point in a gravitational field

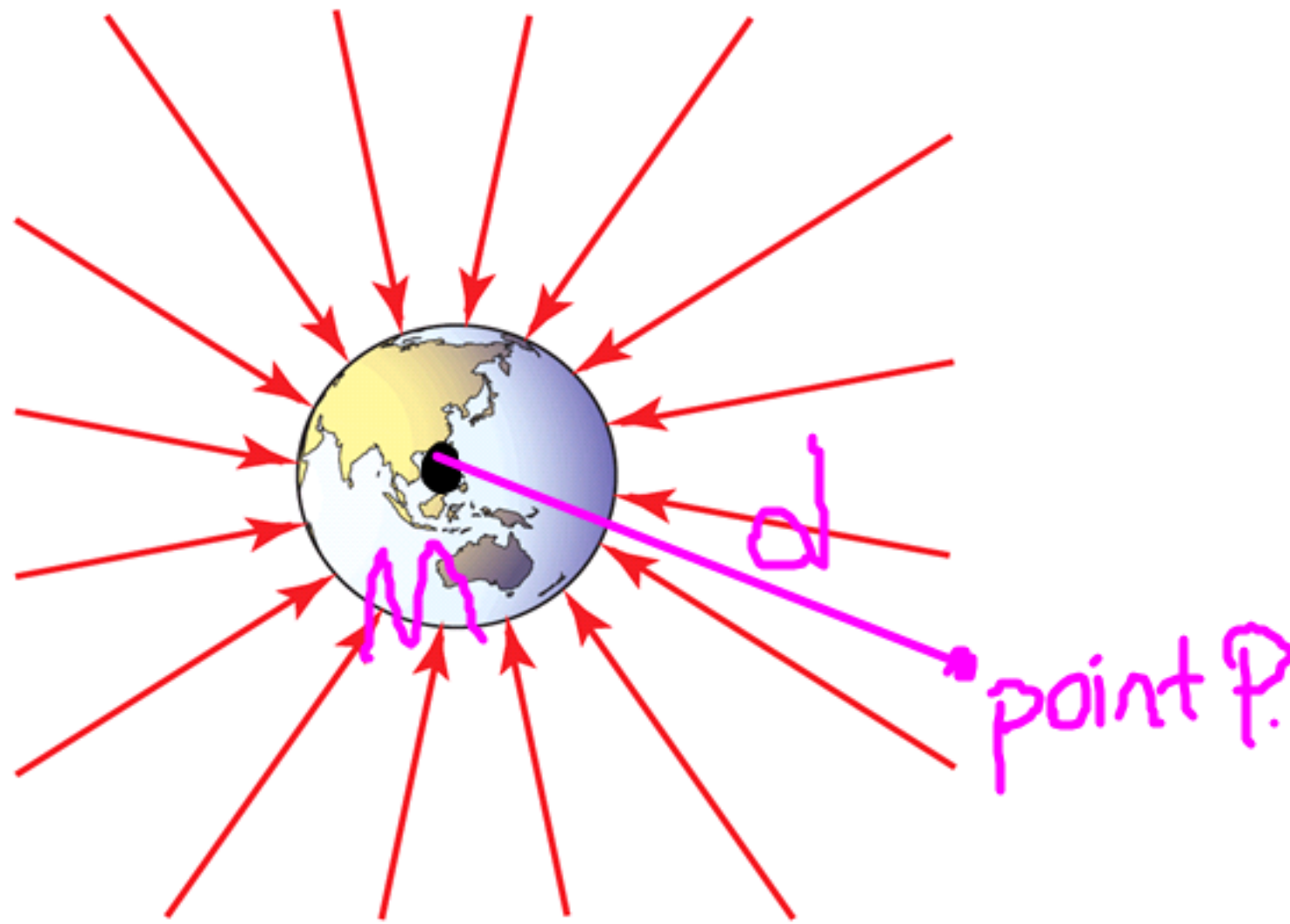
$$E_p = -G \frac{m_1 m_2}{r}$$

Students:

- perform an investigation and gather information to determine a value for acceleration due to gravity using pendulum motion or computer-assisted technology and identify reasons for possible variations from the value 9.8 m s^{-2}
- gather secondary information to predict the value of acceleration due to gravity on other planets
- analyse information using the expression $F = mg$ to determine the weight force for a body on Earth and for the same body on other planets

Gravitational Field around planets

$$g = \frac{G \cdot M}{d^2}$$



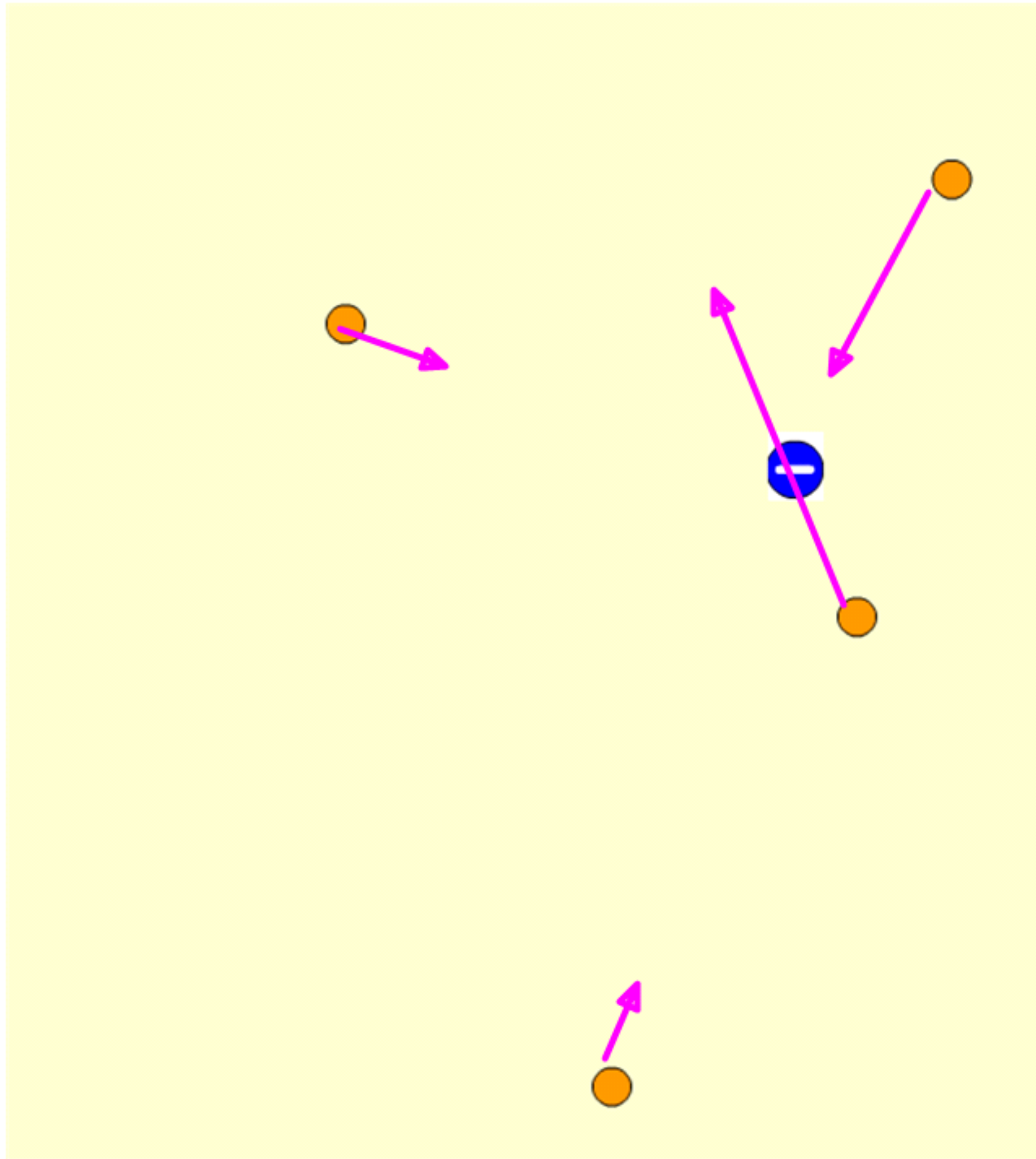
g : gravitational acceleration
or
gravitational field strength

G : Universal gravitational constant
 $6.67 \times 10^{-11} \text{ N m}^2/\text{kg}^2$

M : mass of the planet (centre body)

d : distance from the centre of the planet (m)

Draw "g" for each point around the planet



 Planet

 Various points around the planet

Find the gravitational acceleration on the surface of the Earth.

$$g = \frac{GM}{d^2} = \frac{6.67 \times 10^{-11} \times 5.97 \times 10^{24}}{()^2} = 9.8 \text{ m/s}^2$$

$$d = 6.38 \times 10^6 + 36 \times 10^6 \text{ m}$$

$$\approx 42 \times 10^6$$

655

$g = ?$

0.22

36000 km m/s

$g = 9.8 \text{ m/s}^2$

r_E = radius of the Earth m_E = the mass of the Earth
 $= 6.38 \times 10^6 \text{ m.}$ $= 5.97 \times 10^{24} \text{ kg}$

Universal gravitational constant, G $6.67 \times 10^{-11} \text{ N m}^2 \text{ kg}^{-2}$

Double check one of them!

BODY	MASS (kg)	RADIUS (km)	g (m s ⁻²)
Moon	7.35×10^{22}	1 738	1.6
Mars	6.42×10^{23}	3 397	3.7
Jupiter	1.90×10^{27}	71 492	24.8
Pluto	1.31×10^{22}	1 151	0.66

$$g_p = \frac{6.67 \times 10^{-11} \times 1.31 \times 10^{22}}{(1151 \times 10^3)^2} = 0.66 \text{ m/s}^2$$

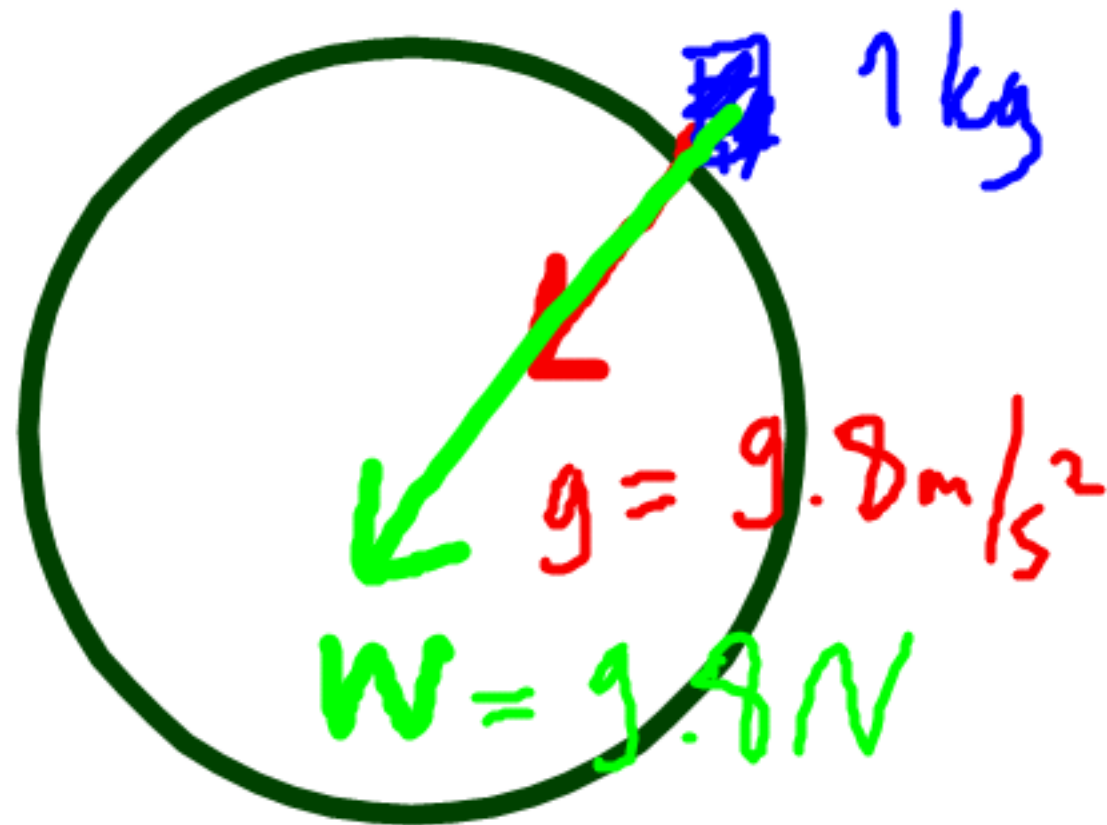
Weight as a Force!

$$W = m \cdot g = 1 \text{ kg} \times 9.8 \text{ m/s}^2 = 9.8 \text{ N}$$

W : weight

m : mass of
the object.

g : gravitational
acceleration
at the location
of " m "



$$\begin{aligned} W &= m \cdot g \\ &= 200 \times 0.22 \\ &= 44 \text{ N} \end{aligned}$$

Find your weight on the surface of earth! Below is mine!

$$\begin{aligned} F &= m \cdot g \\ &= 92 \text{ kg} \times 9.8 \text{ N/kg} \\ &= 901 \text{ N} \end{aligned}$$

Weight is the gravitational ~~force~~ pull on objects / due to the presence of a much larger object, planet)

Is it possible to have "zero weight"?

~~yes~~ ~~no~~

If yes, where?

deep space!

but we "feel" weightless
on earth (lift, crazy drop)

$\frac{1}{d^2}$

Is it possible to have "zero mass"?

~~yes~~ ~~no~~

If no, why?

mass is the measure of matter (particles...)

2001 HSC PAPER

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

$$W = m \cdot g = 9.8 \times 70$$

mass on Earth/mars

$$m_{\text{Earth}}/M = \frac{550}{9.8}$$

2002 HSC PAPER

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

W_E

	Acceleration due to gravity (m s^{-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

$$m = 55 \text{ kg}$$

$$W_{\text{mars}} = 55 \times 3.8 = 213 \text{ N}$$

2003 HSC PAPER

- 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) $\left(\frac{6}{9.8}\right) \text{ms}^{-2}$

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

(C) 9.8ms^{-2}

(D) $(9.8 \times 6) \text{ms}^{-2}$

$$g_{\text{moon}} = \frac{9.8}{6}$$

$$m = \frac{490}{9.8}$$

2008 HSC PAPER

W_e

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

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

(A) 490 N

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

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

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

$$W_{\text{mars}} = \frac{490}{9.8} \times 3.7$$

2007 HSC PAPER

- 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?

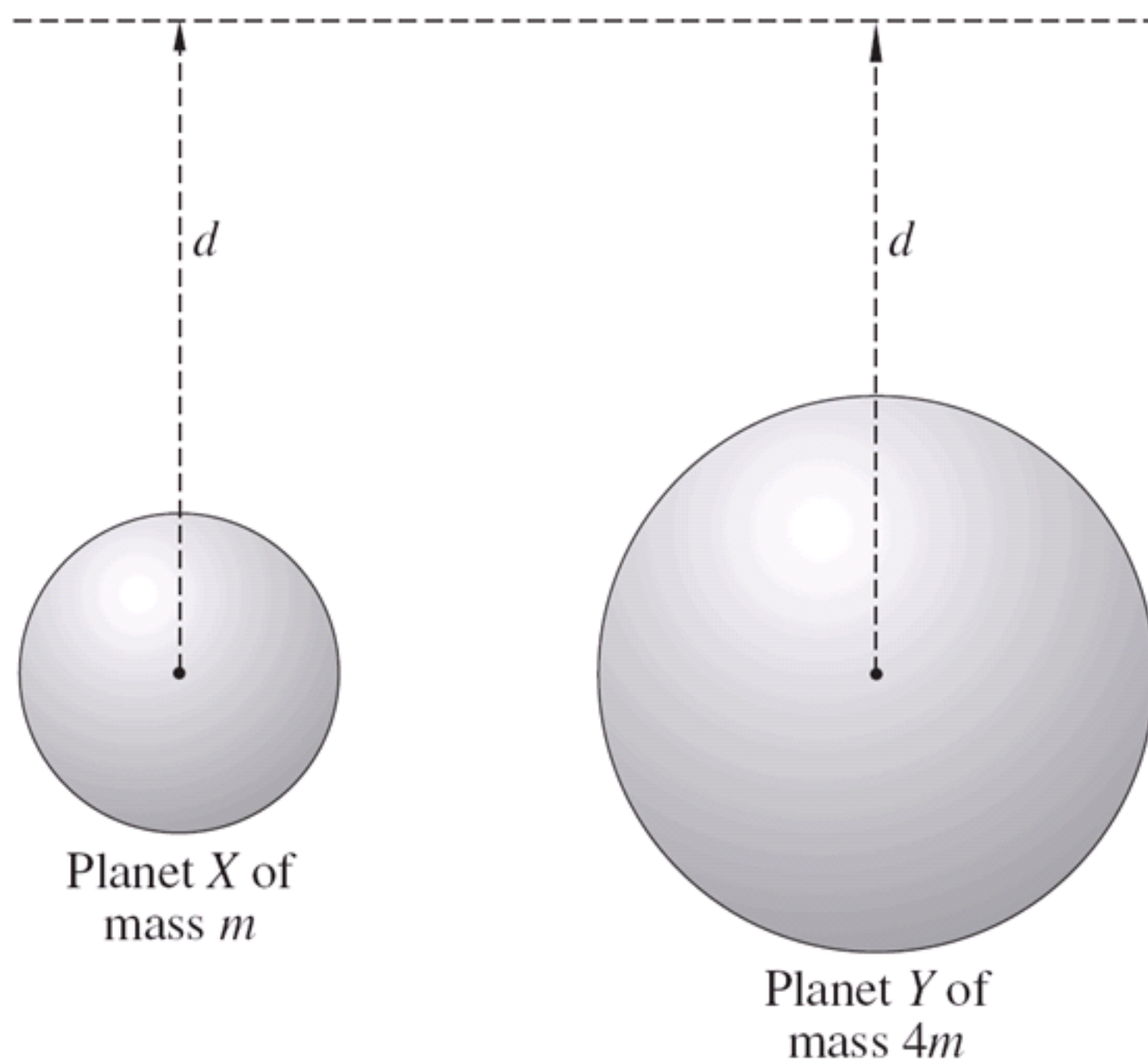
- (A) $\frac{1}{16} g$
- (B) $\frac{1}{4} g$
- (C) $4 g$
- (D) $16 g$

2006 HSC PAPER

- 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.

2004 HSC PAPER

- 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 m s^{-2} .

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

- (A) 1.0 m s^{-2}
- (B) 2.0 m s^{-2}
- (C) 2.8 m s^{-2}
- (D) 4.0 m s^{-2}

HOMEWORK

- ✦ Homework is an integral part of your "Learning Curve", take it seriously!
- ✦ Target minimum 1 hour of Physics everyday
- ✦ Divide your physics home study in three segments;
 - ✓ Revision (past)
 - ✓ Homework (present)
 - ✓ Tomorrow (future)
- ✦ Homework is due next period, unless otherwise stated
- ✦ If you cannot do all, at least do a few from each piece

Apart from reading the relevant pages from the textbook your homework is:

1. Rest of the questions in this booklet
2. Study Chapter 1
3. Chapter 1 questions 1-5

NEXT PERIOD >

VARIATIONS IN "g" and GRAVITATIONAL POTENTIAL ENERGY