IB PHYSICS 2

Name: ___________________________________

Period: ________ Date: ___________________

DEVIL PHYSICS

BADDEST CLASS ON CAMPUS

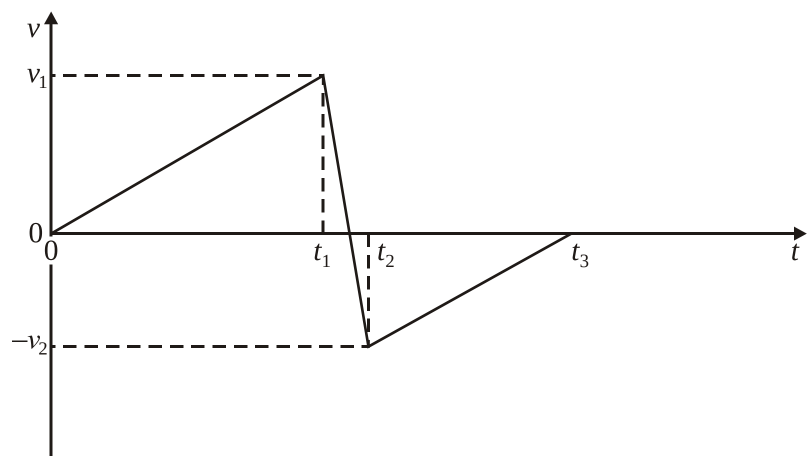
CHAPTER 2B TEST REVIEW

1s. A rocket is fired vertically. At its highest point, it explodes. Which **one** of the following describes what happens to its total momentum and total kinetic energy as a result of the explosion?

	Total momentum	**Total kinetic energy**
A.	unchanged	increased
B.	unchanged	unchanged
C.	increased	increased
D.	increased	unchanged

(1)

3s. A ball of mass *m* falls from rest on to a horizontal plate and bounces off it. The magnitudes of its velocity just before and just after the bounce are v_1 and v_2 respectively. The variation with time *t* of the velocity *v* of the ball is shown below.



The magnitude of the net force on the ball is given by which **one** of the following?

A. $\dfrac{mv_1}{t_1}$

B. $\dfrac{mv_2}{(t_3 - t_2)}$

C. $\dfrac{m(v_1 - v_2)}{(t_2 - t_1)}$

D. $\dfrac{m(v_1 + v_2)}{(t_2 - t_1)}$

(1)

6s. A constant force is applied to a ball of mass *m*. The velocity of the ball changes from v_1 to v_2. The impulse received by the ball is

A. $m(v_2 + v_1)$.
B. $m(v_2 - v_1)$.
C. $m(v_2^2 + v_1^2)$.
D. $m(v_2^2 - v_1^2)$.

(1)

7s. This question is about the collision between two railway trucks (carts).

(a) Define *linear momentum*.

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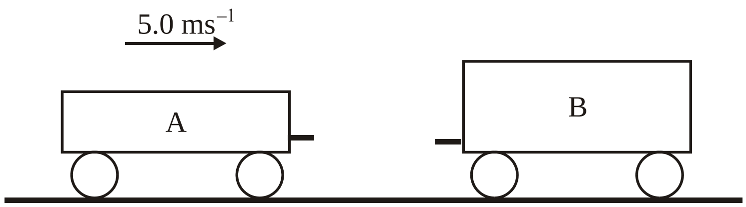
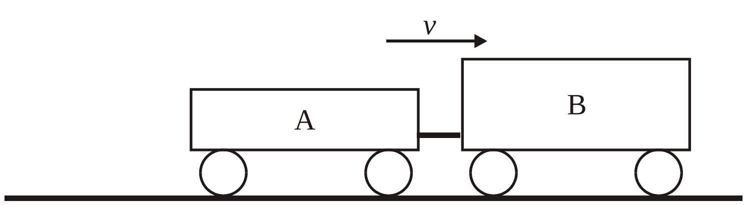
(1)

In the diagram below, railway truck A is moving along a horizontal track. It collides with a stationary truck B and on collision, the two join together. Immediately before the collision, truck A is moving with speed 5.0 ms^{-1}. Immediately after collision, the speed of the trucks is *v*.



Immediately before collision



Immediately after collision

The mass of truck A is 800 kg and the mass of truck B is 1200 kg.

(b) (i) Calculate the speed v immediately after the collision.

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(3)

(ii) Calculate the total kinetic energy lost during the collision.

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(2)

(c) Suggest what has happened to the lost kinetic energy.

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(2)
(Total 8 marks)

9s. This question is about conservation of momentum and conservation of energy.

(a) State Newton's third law.

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(1)

(b) State the law of conservation of momentum.

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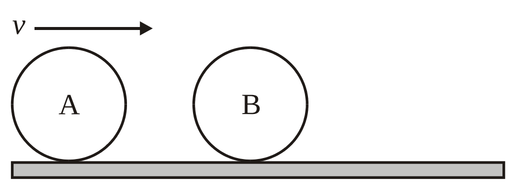
(2)

The diagram below shows two identical balls A and B on a horizontal surface. Ball B is at rest and ball A is moving with speed V along a line joining the centres of the balls. The mass of each ball is M.

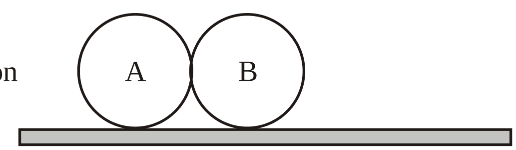
Before collision



During the collision of the balls, the magnitude of the force that ball A exerts on ball B is F_{AB} and the magnitude of the force that ball B exerts on ball A is F_{BA}.

(c) On the diagram below, add labelled arrows to represent the magnitude and direction of the forces F_{AB} and F_{BA}.

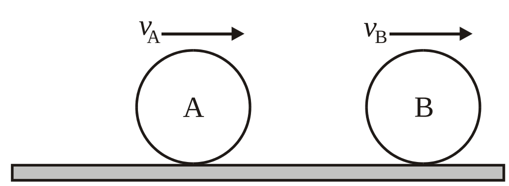
During the collision



(3)

The balls are in contact for a time Δt. After the collision, the speed of ball A is $+v_A$ and the speed of ball B is $+v_B$ in the directions shown.

After the collision



As a result of the collision, there is a change in momentum of ball A and of ball B.

(d) Use Newton's second law of motion to deduce an expression relating the forces acting during the collision to the change in momentum of

(i) ball B.

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(2)

(ii) ball A.

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(2)

(e) Apply Newton's third law and your answers to (d), to deduce that the change in momentum of the system (ball A and ball B) as a result of this collision, is zero.

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(4)

(f) Deduce, that if kinetic energy is conserved in the collision, then after the collision, ball A will come to rest and ball B will move with speed V.

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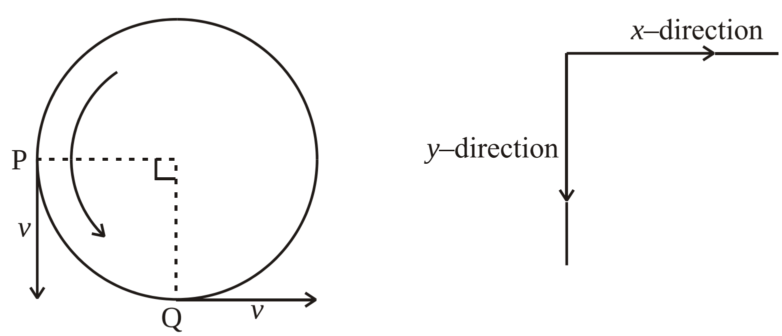
(3)
(Total 17 marks)

10s. A stone on a string is moving in a circle as shown below.



At point P, the stone of mass m has speed v in the y-direction. A quarter of a revolution later, the stone at point Q has speed v in the x-direction.

What is the change, in the *y*-direction **only**, of the magnitude of the momentum of the stone?

A. zero
B. mv
C. $\sqrt{2}mv$
D. $2mv$

(1)

13s. This question is about momentum and the kinematics of a proposed journey to Jupiter.

(a) State the law of conservation of momentum.

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(2)

A solar propulsion engine uses solar power to ionize atoms of xenon and to accelerate them. As a result of the acceleration process, the ions are ejected from the spaceship with a speed of 3.0×10^4 m s^{-1}.

(b) The mass (nucleon) number of the xenon used is 131. Deduce that the mass of one ion of xenon is 2.2×10^{-25} kg.

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(2)

(c) The original mass of the fuel is 81 kg. Deduce that, if the engine ejects 77×10^{18} xenon ions every second, the fuel will last for 1.5 years. (1 year = 3.2×10^7 s)

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(2)

(d) The mass of the spaceship is 5.4×10^2 kg. Deduce that the initial acceleration of the spaceship is 8.2×10^{-5} m s^{-2}.

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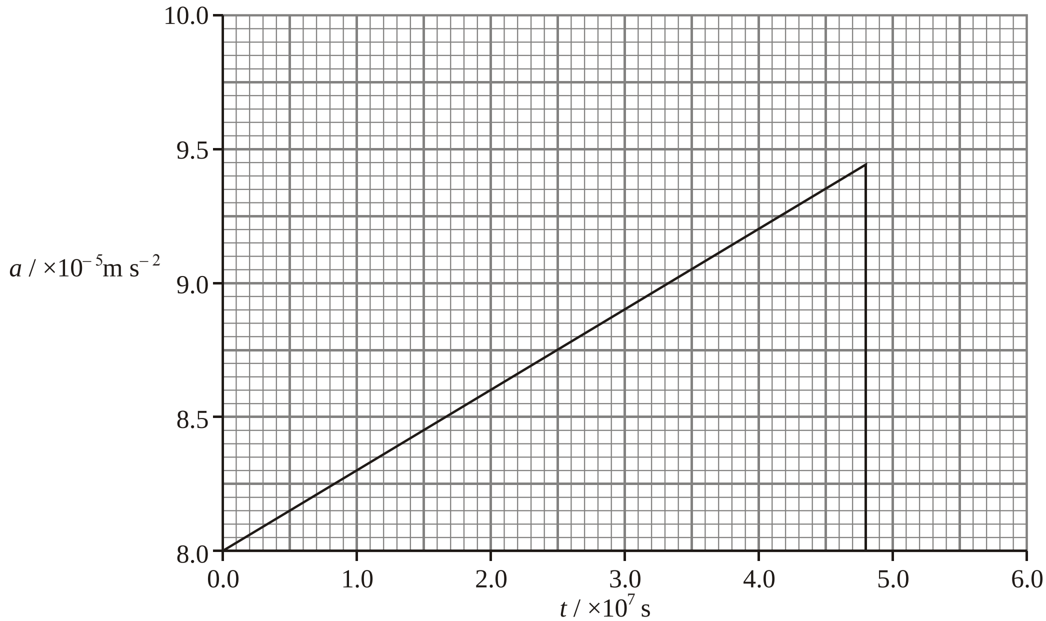
(5)

The graph below shows the variation with time t of the acceleration a of the spaceship. The solar propulsion engine is switched on at time $t = 0$ when the speed of the spaceship is 1.2×103 m s^{-1}.



(e) Explain why the acceleration of the spaceship is increasing with time.

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(2)

(f) Using data from the graph, calculate the speed of the spaceship at the time when the xenon fuel has all been used.

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(4)

(g) The distance of the spaceship from Earth when the solar propulsion engine is switched on is very small compared to the distance from Earth to Jupiter. The fuel runs out when the spaceship is a distance of 4.7×10^{-11} m from Jupiter. Estimate the total time that it would take the spaceship to travel from Earth to Jupiter.

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(2)
(Total 19 marks)

20s. An object of mass m is initially at rest. An impulse I acts on the object. The change in kinetic energy of the object is

A. $\frac{I^2}{2m}$.

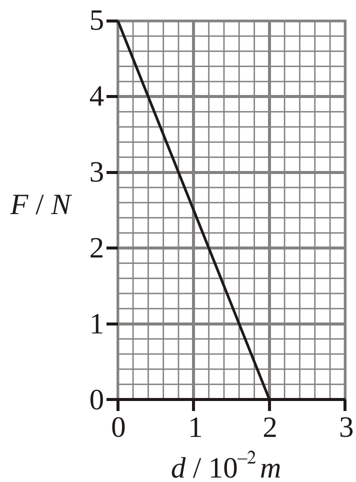
B. $\frac{I^2}{m}$.

C. I^2m.

D. $2I^2m$.

(1)

26s. The graph below shows the variation with displacement d of the force F applied by a spring on a cart.



The work done by the force in moving the cart through a distance of 2 cm is

A. 10×10^{-2}J.

B. 7×10^{-2}J.

C. 5×10^{-2}J.

D. 2.5×10^{-2}J.

(1)

30s. A machine lifts an object of weight 1.5×10^3 N to a height of 10 m. The machine has an overall efficiency of 20%. The work done by the machine in raising the object is

A. 3.0×10^3 J.

B. 1.2×10^4 J.

C. 1.8×10^4 J.

D. 7.5×10^4 J.

(1)

33s. This question is about the kinematics and dynamics of circular motion.

(a) A car goes round a curve in a road at constant speed. Explain why, although its speed is constant, it is accelerating.

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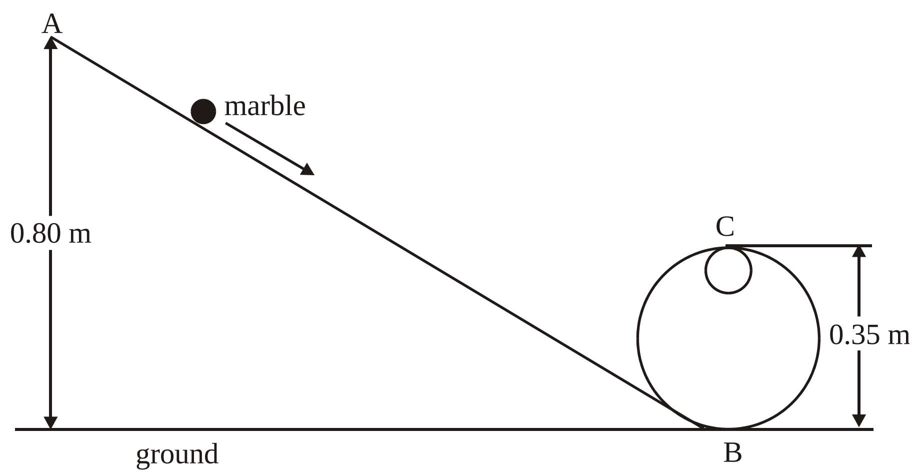
(2)

In the diagram below, a marble (small glass sphere) rolls down a track, the bottom part of which has been bent into a loop. The end A of the track, from which the marble is released, is at a height of 0.80 m above the ground. Point B is the lowest point and point C the highest point of the loop. The diameter of the loop is 0.35 m.



The mass of the marble is 0.050 kg. Friction forces and any gain in kinetic energy due to the rotating of the marble can be ignored. The acceleration due to gravity, $g = 10\ \text{ms}^{-2}$.

Consider the marble when it is at point C.

(b) (i) On the diagram opposite, draw an arrow to show the direction of the resultant force acting on the marble.

(1)

(ii) State the names of the **two** forces acting on the marble.

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(2)

(iii) Deduce that the speed of the marble is $3.0\ \text{ms}^{-1}$.

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(3)

(iv) Determine the resultant force acting on the marble and hence determine the reaction force of the track on the marble.

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(4)
(Total 12 marks)

37s. A box of mass *m* is moved horizontally against a constant frictional force *f* through a distance *s* at constant speed *v*. The work done on the box is

A. 0.

B. *mgs*.

C. $\frac{1}{2}mv^2$.

D. *fs*.

(1)

42s. Mechanical power

(a) Define *power*.

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(1)

(b) A car is travelling with constant speed *v* along a horizontal straight road. There is a total resistive force *F* acting on the car.

Deduce that the power *P* to overcome the force *F* is

$$P = Fv.$$

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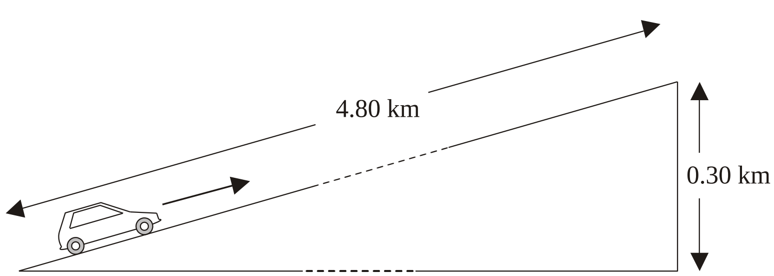
(2)

(c) A car drives up a straight incline that is 4.80 km long. The total height of the incline is 0.30 km.



The car moves up the incline at a steady speed of 16 m s^{-1}. During the climb, the average resistive force acting on the car is 5.0×10^2 N. The total weight of the car and the driver is 1.2×10^4 N.

(i) Determine the time it takes the car to travel from the bottom to the top of the incline.

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(2)

(ii) Determine the work done against the gravitational force in travelling from the bottom to the top of the incline.

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(1)

(iii) Using your answers to (i) and (ii), calculate a value for the minimum power output of the car engine needed to move the car from the bottom to the top of the incline.

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(4)

(iv) State **one** reason why your answer to (iii) is only an estimate.

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(1)

(Total 11 marks)

44s. A body moving along a straight-line has mass 3.0 kg and kinetic energy 24 J. The motion is then opposed by a net force of 4.0 N. The body will come to rest after travelling a distance of

A. 2.0 m.

B. 6.0 m.

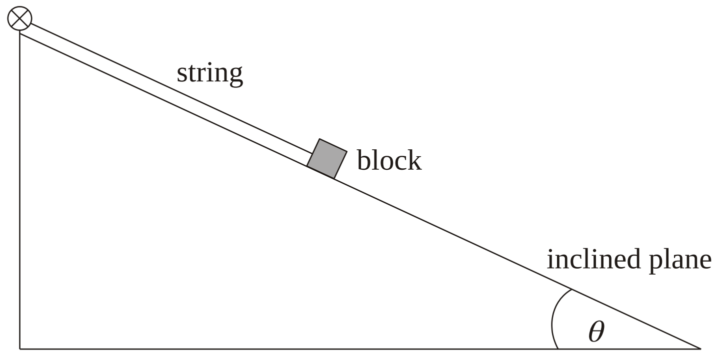
C. 8.0 m.

D. 12 m.

(1)

46s. Block on an inclined plane

A block is held stationary on a frictionless inclined plane by means of a string as shown below.



(a) (i) On the diagram draw arrows to represent the three forces acting on the block.

(3)

(ii) The angle θ of inclination of the plane is 25°. The block has mass 2.6 kg. Calculate the force in the string. You may assume that g = 9.8 m s^{-2}.

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(2)

(b) The string is pulled so that the block is now moving at a constant speed of 0.85 m s^{-1} up the inclined plane.

(i) Explain why the magnitude of the force in the string is the same as that found in (a)(ii).

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(2)

(ii) Calculate the power required to move the block at this speed.

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(2)

(iii) State the rate of change of the gravitational potential energy of the block. Explain your answer.

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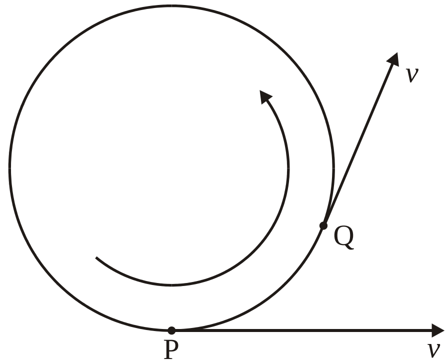
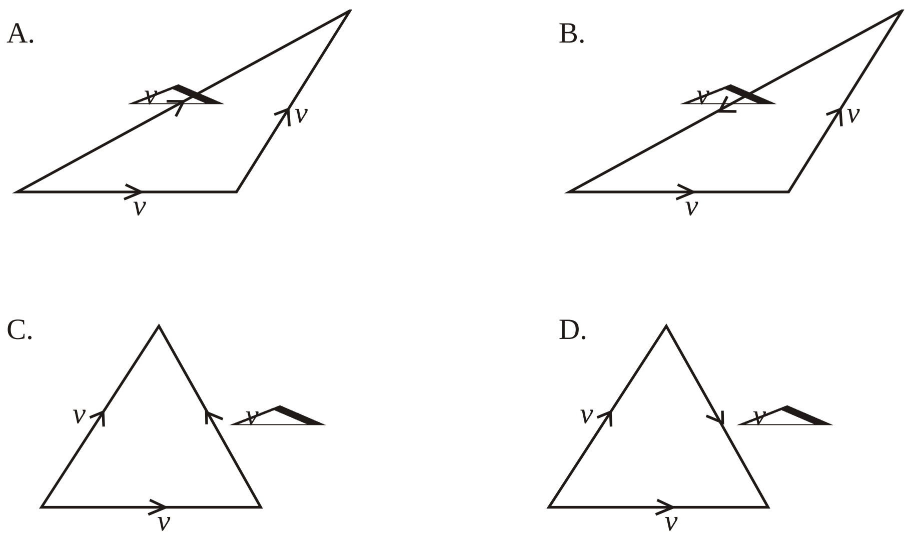
(2)
(Total 11 marks)

53s. A point mass is moving in a horizontal circle with a velocity of constant magnitude *v*. At one particular time, the mass is at P. A short time later, the mass is at Q, as shown below.



Which vector diagram correctly shows the change in velocity Δv of the mass during this time?

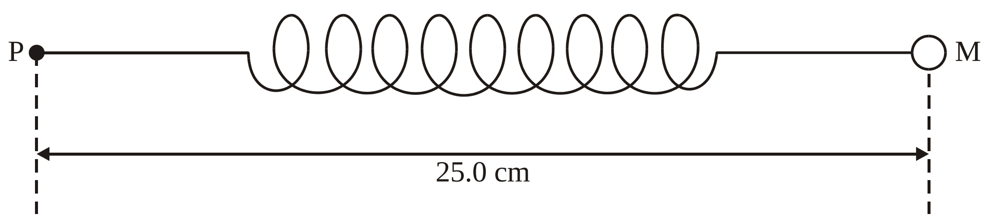


(1)

54s. This question is about circular motion.

A linear spring of negligible mass requires a force of 18.0 N to cause its length to increase by 1.0 cm.

A sphere of mass 75.0 g is attached to one end of the spring. The distance between the centre of the sphere M and the other end P of the unstretched spring is 25.0 cm, as shown below.



The sphere is rotated at constant speed in a horizontal circle with centre P. The distance PM increases to 26.5 cm.

(a) Explain why the spring increases in length when the sphere is moving in a circle.

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(2)

(b) Determine the speed of the sphere.

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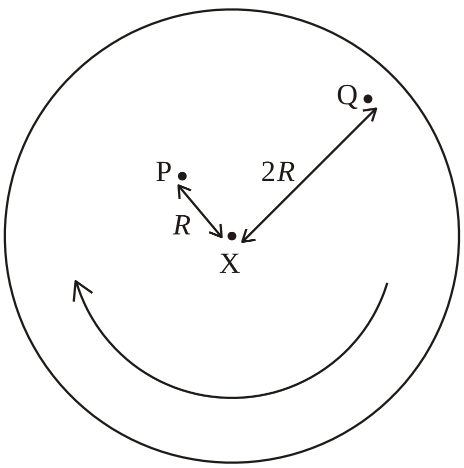
(4)
(Total 6 marks)

56s. Points P and Q are at distances *R* and 2*R* respectively from the centre X of a disc, as shown below.



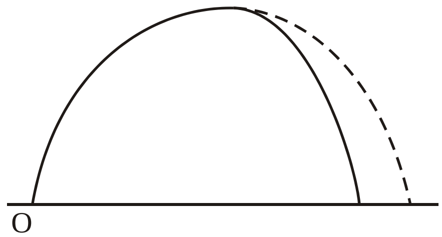
The disc is rotating about an axis through X, normal to the plane of the disc. Point P has linear speed *v* and centripetal acceleration *a*. Which **one** of the following is correct for point Q?

	Linear speed	Centripetal acceleration
A.	v	a
B.	v	$2a$
C.	$2v$	$2a$
D.	$2v$	$4a$

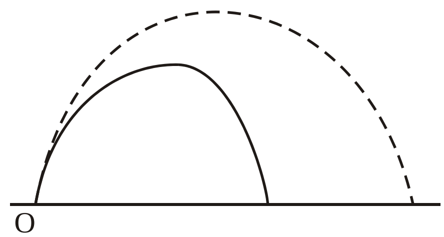
(1)

60s. A stone is thrown from O at an angle to the horizontal. Which sketch below best shows the path of the stone when air resistance is **not** neglected? On each sketch, the broken line shows the path for the same stone in a vacuum.

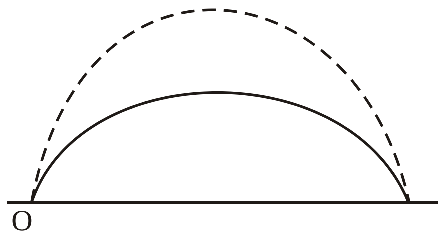
A.



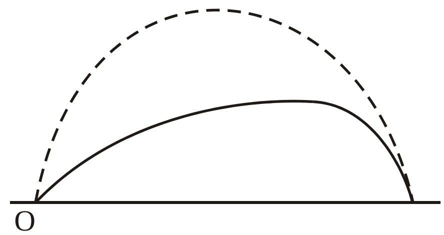
B.



C.



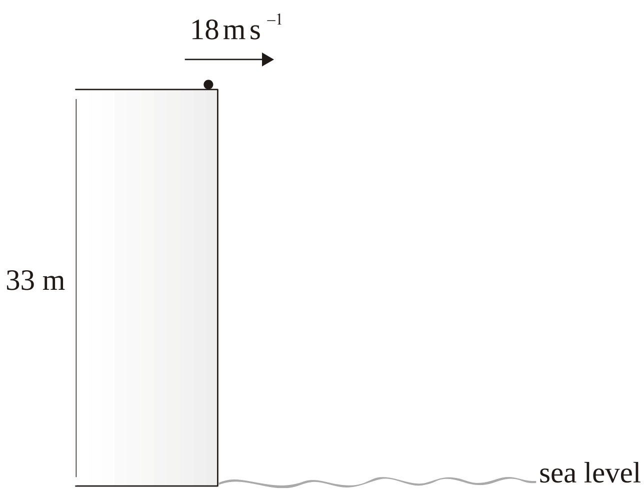
D.



(1)

64s. This question is about projectile motion.

A stone is thrown horizontally from the top of a vertical cliff of height 33 m as shown below.



The initial horizontal velocity of the stone is 18 m s^{-1} and air resistance may be assumed to be negligible.

(a) State values for the horizontal and for the vertical acceleration of the stone.

Horizontal acceleration: ....

Vertical acceleration: ....

(2)

(b) Determine the time taken for the stone to reach sea level.

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(2)

(c) Calculate the distance of the stone from the base of the cliff when it reaches sea level.

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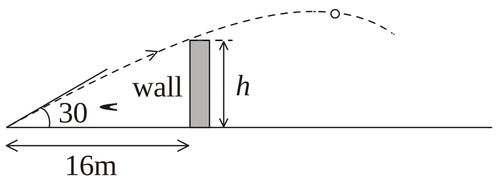
(1)
(Total 5 marks)

66s. This question is about projectile motion.

A ball is projected from ground level with a speed of 28 m s^{-1} at an angle of 30° to the horizontal as shown below.



There is a wall of height h at a distance of 16 m from the point of projection of the ball. Air resistance is negligible.

(a) Calculate the initial magnitudes of

(i) the horizontal velocity of the ball;

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(1)

(ii) the vertical velocity of the ball.

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(1)

(b) The ball just passes over the wall. Determine the maximum height of the wall.

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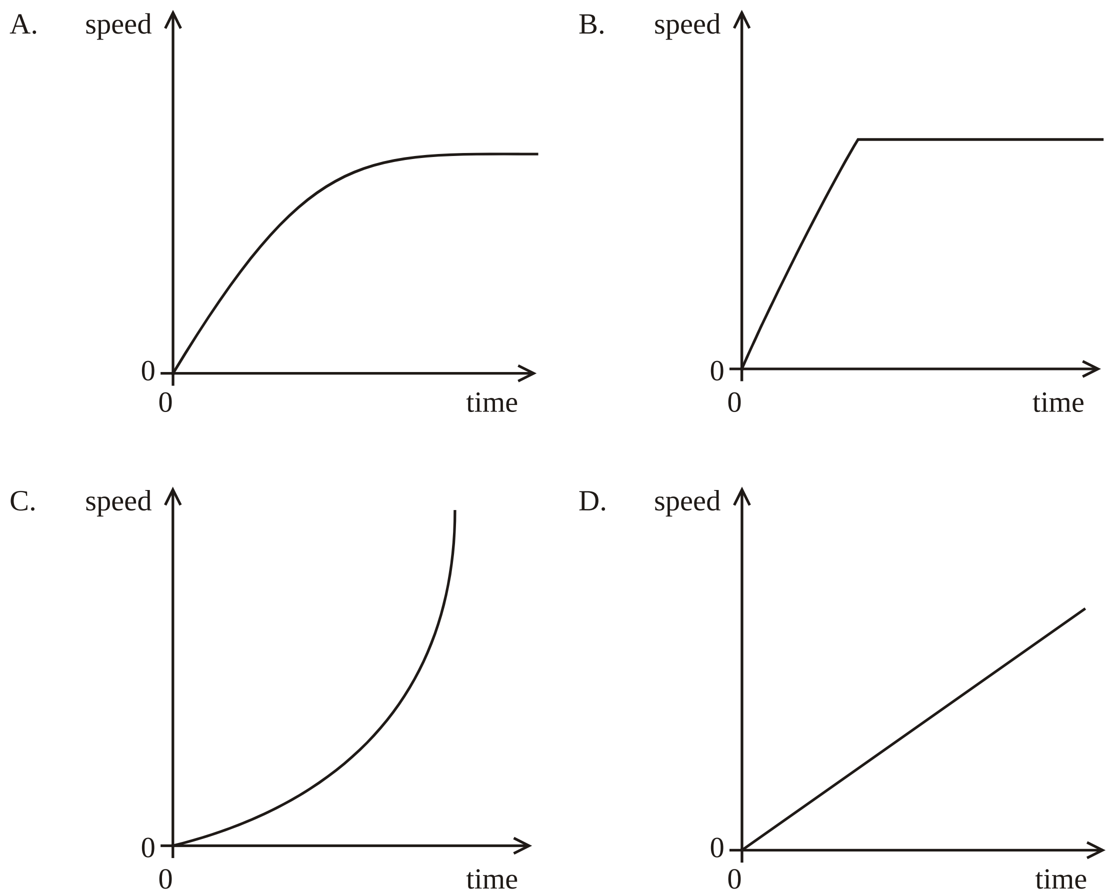
(3)
(Total 5 marks)

68s. A steel sphere is dropped from rest in oil. Which of the following graphs best represents the variation with time of the speed of the sphere?



(1)

70s. This question is about gravitation and orbital motion.

(a) Define *gravitational field strength* at a point in a gravitational field.

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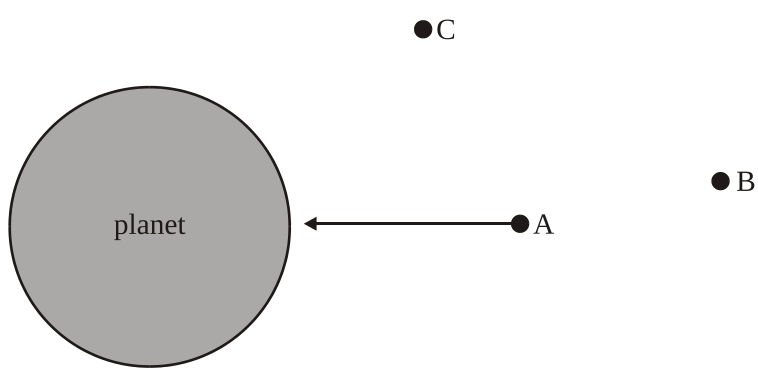
(2)

The diagram below shows three points above a planet. The arrow represents the gravitational field strength at point A.



(b) Draw arrows to represent the gravitational field strength at point B and point C.

(2)
(Total 4 marks)

72s. This question is about gravitation.

A space probe is launched from the equator in the direction of the north pole of the Earth. During the launch, the energy E given to the space probe of mass m is

$$E = \frac{3GMm}{4R_e}$$

where G is the Gravitational constant and M and R_e are, respectively, the mass and radius of the Earth. Work done in overcoming frictional forces is not to be considered.

(a) (i) Explain what is meant by *escape speed*.

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(2)

(ii) Deduce that the space probe will not be able to travel into deep space.

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(3)

The space probe is launched into a circular polar orbit of radius R.

(b) Derive expressions, in terms of G, M, R_e, m and R, for

(i) the change in gravitational potential energy of the space probe as a result of travelling from the Earth's surface to its orbit.

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(1)

(ii) the kinetic energy of the space probe when in its orbit.

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(2)

(c) Using your answers in (b) and the total energy supplied to the space probe as given in (a), determine the height of the orbit above the Earth's surface.

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.... **(4)**

A space probe in a low orbit round the Earth will experience friction due to the Earth's atmosphere.

(d) (i) Describe how friction with the air reduces the energy of the space probe.

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.... **(2)**

(ii) Suggest why the rate of loss of energy of the space probe depends on the density of the air and also the speed of the space probe.

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.... **(2)**

(iii) State what will happen to the height of the space probe above the Earth's surface and to its speed as air resistance gradually reduces the total energy of the space probe.

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.... **(2)**

(Total 18 marks)

76s. This question is about gravitation.

(a) (i) Define *gravitational potential* at a point in a gravitational field.

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.... **(2)**

(ii) Explain why values of gravitational potential have negative values.

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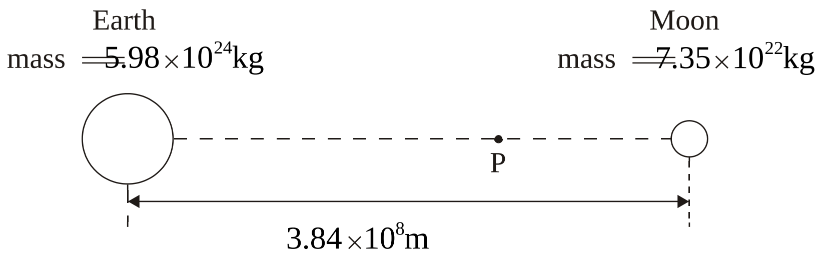
.... **(2)**

The Earth and the Moon may be considered to be two isolated point masses. The masses of the Earth and the Moon are 5.98×10^{24}kg and 7.35×10^{22} kg respectively and their separation is 3.84×10^{8} m, as shown below. The diagram is not to scale.



(b) (i) Deduce that, at point P, 3.46×10^8 m from Earth, the gravitational field strength is approximately zero.

(3)

(ii) The gravitational potential at P is -1.28×10^6 J kg^{-1}. Calculate the minimum speed of a space probe at P so that it can escape from the attraction of the Earth and the Moon.

(3)
(Total 10 marks)

77s. This question is about a spacecraft.

A spacecraft above Earth's atmosphere is moving away from the Earth. The diagram below shows two positions of the spacecraft. Position A and position B are well above Earth's atmosphere.

At position A, the rocket engine is switched off and the spacecraft begins coasting freely. At position A, the speed of the spacecraft is 5.37×10^3 m s^{-1} and at position B, 5.10×10^3 m s^{-1}. The time to travel from position A to position B is 6.00×10^2 s.

(a) (i) Explain why the speed is changing between positions A and B.

(1)

(ii) Calculate the average acceleration of the spacecraft between positions A and B.

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(2)

(iii) Estimate the average gravitational field strength between positions A and B. Explain your working.

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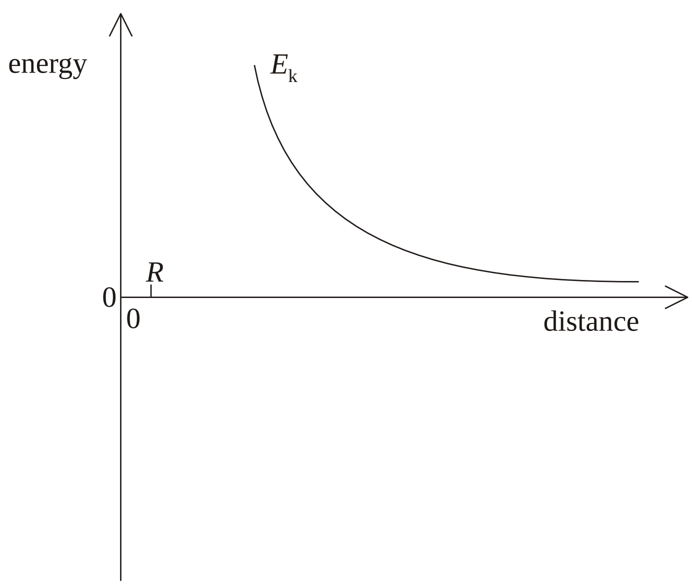
(3)

(b) The diagram below shows the variation with distance from Earth of the kinetic energy E_k of the spacecraft. The radius of Earth is R.



On the diagram above, draw the variation with distance from the surface of Earth of the gravitational potential energy E_p of the spacecraft.

(2)
(Total 8 marks)