SECTION 1

1.1. An object falls freely from rest. After falling a distance d its velocity is v. What is its velocity after it has fallen a distance $2d$?

A $2\,v$

B $4\,v$

C $2\,v^2$

D $\sqrt{2}\,v$

(Total 1 mark)

1.2. Which of the following is a scalar quantity?

A velocity

B kinetic energy

C force

D momentum

(Total 1 mark)

1.3. An object is dropped from a cliff. How far does the object fall in the third second? Assume that g = 10 ms^{-2}.

A 10 m

B 20 m

C 25 m

D 45 m

(Total 1 mark)

1.4. Which of the following is **not** a unit of power?

A Nms^{-1}

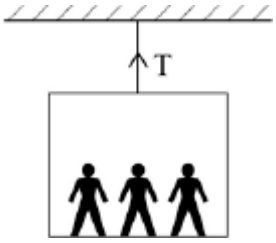
B kgm^2s^{-3}

C Js^{-1}

D $kgm^{-1}s^{-1}$

(Total 1 mark)

1.5. A lift and its passengers with a total mass of 500 kg accelerates upwards at 2 ms^{-2} as shown. Assume that g = 10 ms^{-2}.



What is the tension in the cable?

A 1000 N

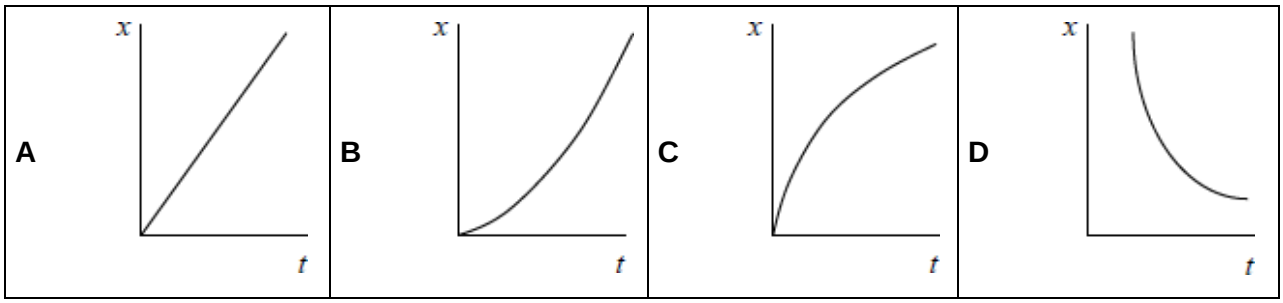
B 4000 N

C 5000 N

D 6000 N

(Total 1 mark)

1.6. A car accelerates uniformly from rest along a straight road. Which graph shows the variation of displacement x of the car with time t?



(Total 1 mark)

1.7. A ball bearing **X** of mass 2m is projected vertically upwards with speed u. A ball bearing **Y** of mass m is projected at 30° to the horizontal with speed 2u at the same time. Air resistance is negligible. Which of the following statements is correct?

A The horizontal component of **Y**'s velocity is u.

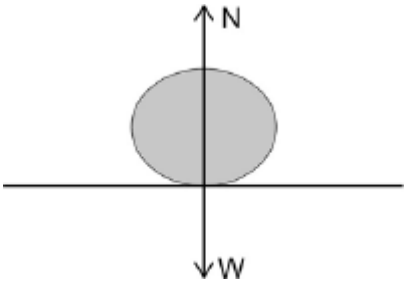
B The maximum height reached by **Y** is half that reached by **X**

C **X** and **Y** reach the ground at the same time.

D **X** reaches the ground first.

(Total 1 mark)

1.8. The diagram shows the two forces, N and W, acting on a ball which is at rest on a table.



N and W are equal in magnitude. Which law indicates that N and W are equal in magnitude?

A conservation of momentum

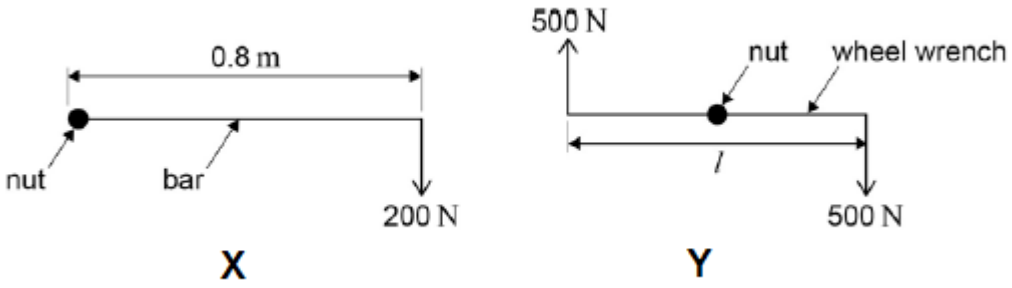
B Newton's first law

C conservation of energy

D Newton's third law

(Total 1 mark)

1.9. A car wheel nut can be loosened by applying a force of 200 N on the end of a bar of length 0.8 m as in **X**. A car mechanic is capable of applying forces of 500 N simultaneously in opposite directions on the ends of a wheel wrench as in **Y**.



What is the minimum length l of the wrench which would be needed for him to loosen the nut?

A 0.16 m

B 0.32 m

C 0.48 m

D 0.64 m

(Total 1 mark)

1.10. What is the relationship between the distance y travelled by an object falling freely from rest and the time x the object has been falling?

A y is proportional to x^2

B y is proportional to $\sqrt{x}$

C y is proportional to $\frac{1}{x}$

D y is proportional to $\frac{1}{x^2}$

(Total 1 mark)

1.11. A car exerts a driving force of 500 N when travelling at a constant speed of 72 kmh^{-1} on a level track. What is the work done in 5 minutes?

A 3.0×10^6 J

B 2.0×10^6 J

C 2.0×10^5 J

D 1.1×10^5 J

(Total 1 mark)

1.12. Two forces of 6 N and 10 N act at a point. Which of the following could **not** be the magnitude of the result?

A 16 N

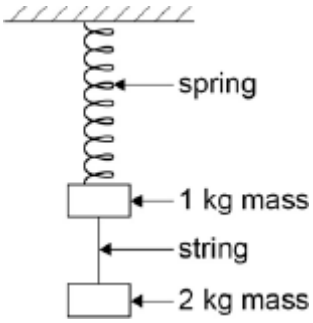
B 8 N

C 5 N

D 3 N

(Total 1 mark)

1.13. Two masses hang at rest from a spring, as shown in the diagram. The string separating the masses is burned through.



Which of the following gives the accelerations of the two masses as the string breaks?

acceleration of free fall = g

	acceleration of 1 kg mass upwards in ms^{-2}	acceleration of 2 kg mass downwards in ms^{-2}
A	3 g	1 g
B	2 g	2 g
C	2 g	1 g
D	1 g	1 g

(Total 1 mark)

1.14. An electric motor of input power 100 W raises a mass of 10 kg vertically at a steady speed of 0.5 ms^{-1}. What is the efficiency of the system?

A 5%

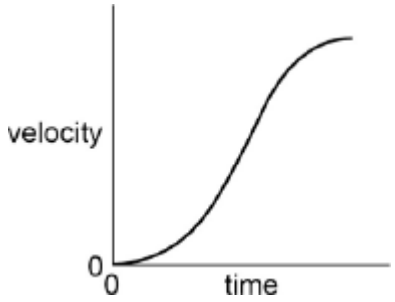
B 12%

C 50%

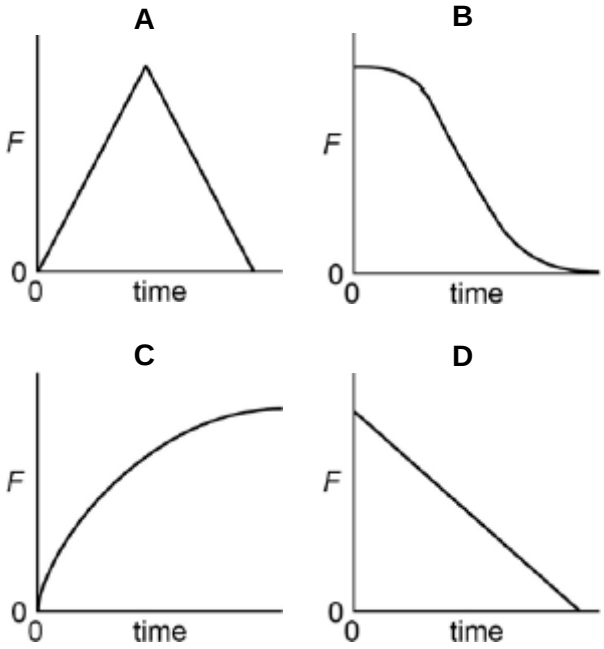
D 100%

(Total 1 mark)

1.15. The velocity of a vehicle varies with time as shown by the following graph.



Which graph below represents how the resultant force F on the car varies during the same time?



(Total 1 mark)

SECTION 2

2.1. Which line, **A** to **D**, in the table shows correctly whether the moment of a force, and momentum, are scalar or vector quantities?

	moment of force	**momentum**
A	scalar	scalar
B	scalar	vector
C	vector	scalar
D	vector	vector

(Total 1 mark)

2.2. A body X moving with a velocity *v* makes an elastic collision with a stationary body Y of equal mass on a smooth horizontal surface.

Which line, **A** to **D**, in the table gives the velocities of the two bodies after the collision?

	velocity of X	**velocity of Y**
A	$\frac{v}{2}$	$-\frac{v}{2}$
B	$-\frac{v}{2}$	$\frac{v}{2}$
C	v	0
D	0	v

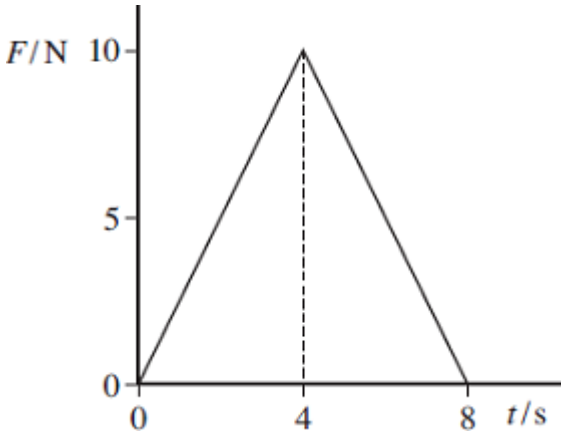
(Total 1 mark)

2.3. Two ice skaters, initially at rest and in contact, push apart from each other.
Which line, **A** to **D**, in the table states correctly the change in the total momentum and the total kinetic energy of the two skaters?

	total momentum	**total kinetic energy**
A	unchanged	increases
B	unchanged	unchanged
C	increases	increases
D	increases	unchanged

(Total 1 mark)

2.4. A ball of mass 2.0 kg, initially at rest, is acted on by a force *F* which varies with time *t* as shown by the graph.



What is the velocity of the ball after 8.0 s?

A 20 ms^{-1}

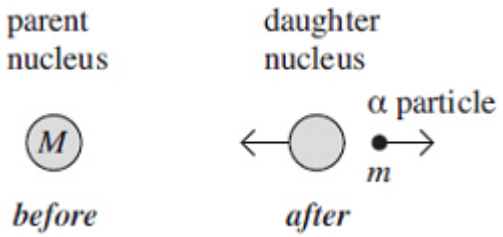
B 40 ms^{-1}

C 80 ms^{-1}

D 160 ms^{-1}

(Total 1 mark)

2.5. A stationary unstable nucleus of mass *M* emits an α particle of mass *m* with kinetic energy *E*.



What is the speed of recoil of the daughter nucleus?

A $\frac{\sqrt{2mE}}{(M-m)}$

B $\frac{\sqrt{2mE}}{M}$

C $\frac{(M-m)}{\sqrt{2mE}}$

D $\frac{2mE}{(M-m)^2}$

(Total 1 mark)

2.6. A cricket ball of mass 0.16 kg travelling at a speed of 35 ms^{-1} is hit by a bat and, as a result of the impact, leaves the bat in the opposite direction at 30 ms^{-1}. If the duration of the impact is 52 ms, what is the magnitude of the average force on the ball?

A 0.015 N

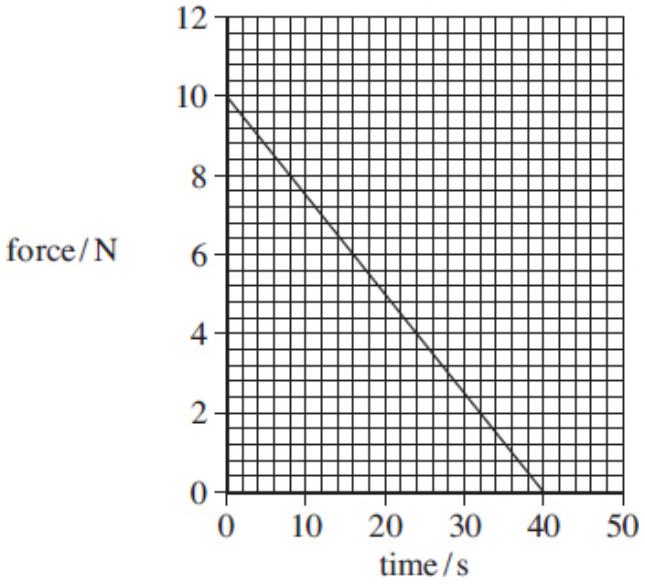
B 0.20 N

C 15 N

D 200 N

(Total 1 mark)

2.7. The graph shows how the force acting on a body changes with time.



The body has a mass of 0.25 kg and is initially at rest. What is the speed of the body after 40 s assuming no other forces are acting?

A 200 ms^{-1}

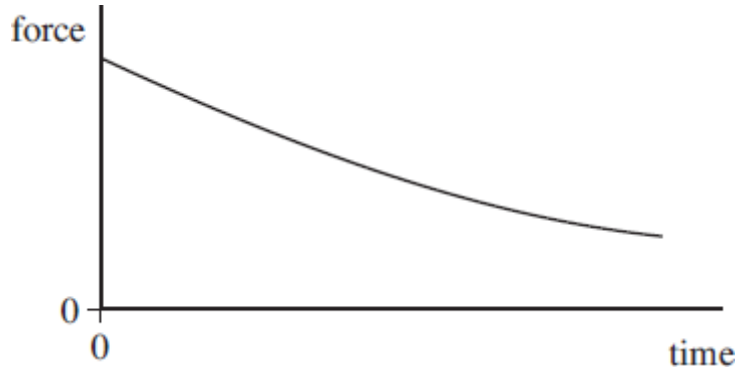
B 400 ms^{-1}

C 800 ms^{-1}

D 1600 ms^{-1}

(Total 1 mark)

2.8. A ball is released so that it falls vertically. The graph shows how the resultant force acting on the ball changes with time.



Which one of the following is represented by the area under the graph?

A distance travelled

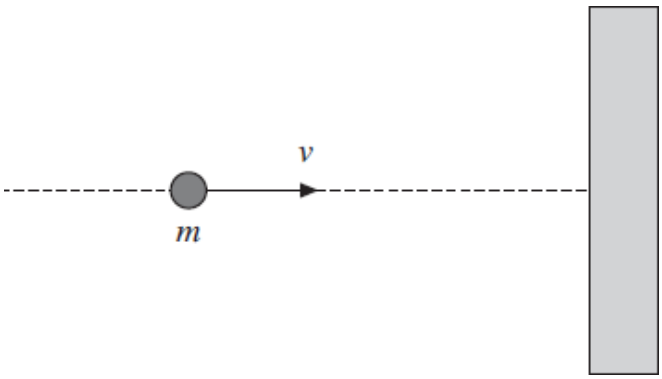
B gain in kinetic energy

C acceleration

D impulse

(Total 1 mark)

2.9. A ball of mass *m* travelling at velocity *v* collides normally with a smooth wall, as shown in the diagram, and rebounds elastically.



Which line, **A** to **D**, in the table, gives the correct expressions for the magnitude of the change of momentum, and the change of kinetic energy, of the ball?

	magnitude of change of momentum	**change of kinetic energy**
A	*2mv*	*0*
B	*2mv*	mv^2
C	*0*	*0*
D	*0*	mv^2

(Total 1 mark)

2.10. A gas molecule of mass *m* moving at velocity *u* collides at right angles with the side of a container and rebounds elastically. Which one of the following statements concerning the motion of the molecule is **incorrect?**

A The magnitude of the change in momentum of the molecule is zero.

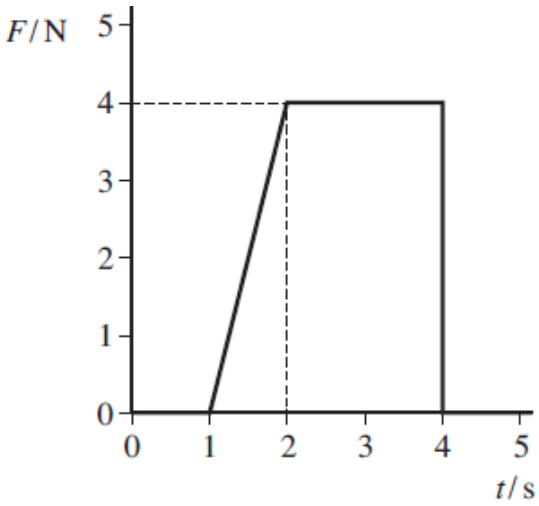
B The magnitude of the change in momentum of the molecule is 2*mu*.

C The force exerted by the molecule on the side of the container is equal to the force exerted by the container on the molecule.

D The change in kinetic energy of the molecule is zero.

(Total 1 mark)

2.11. The graph shows how the resultant force, *F*, acting on a body varies with time, *t*.



What is the change in momentum of the body over the 5 s period?

A 2 Ns

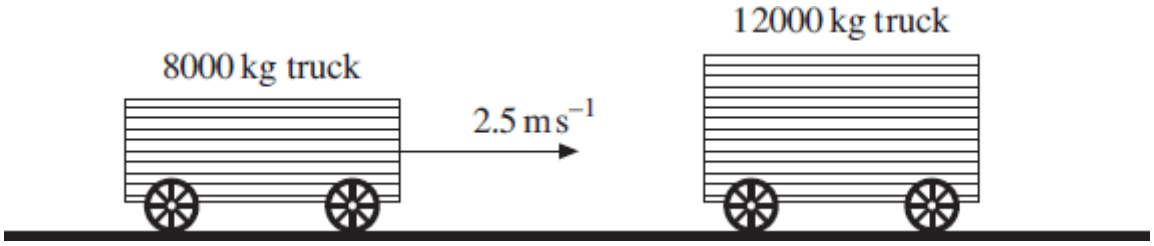
B 8 Ns

C 10 Ns

D 12 Ns

(Total 1 mark)

2.12. A railway truck of mass 8000 kg travels along a level track at a velocity of 2.5 ms^{-1} and collides with a stationary truck of mass 12000 kg. The two trucks move together at the same velocity after the collision.



What is the change in momentum of the 8000 kg truck due to the impact?

A 8000 Ns

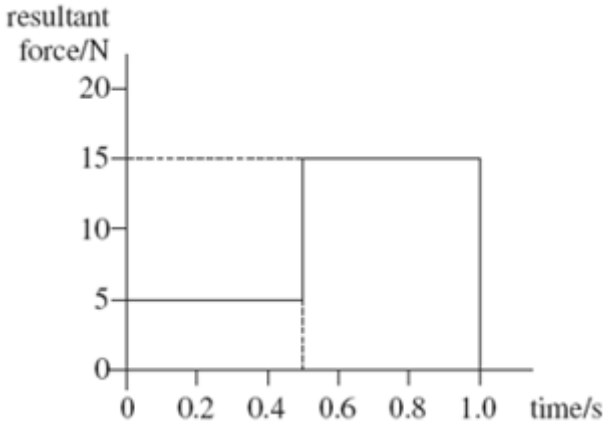
B 12000 Ns

C 20000 Ns

D 25000 Ns

(Total 1 mark)

2.13. The graph shows how the resultant force applied to an object of mass 2.0 kg, initially at rest, varies with time.



What is the speed of the object after 1.0 s?

A 2.5 ms^{-1}

B 5.0 ms^{-1}

C 7.5 ms^{-1}

D 10 ms^{-1}

(Total 1 mark)

2.14. Which of the following is a possible unit for rate of change of momentum?

A Ns

B Ns^{-1}

C $kgms^{-1}$

D $kgms^{-2}$

(Total 1 mark)

2.15. A rail truck X travels along a level track and collides with a stationary truck Y. The two trucks move together at the same velocity after the collision.

Which line, **A** to **D**, in the table states how the total momentum and the total kinetic energy of the trucks change as a result of the impact.

	total momentum	**total kinetic energy**
A	unchanged	unchanged
B	unchanged	decreases
C	decreases	decreases
D	decreases	unchanged

(Total 1 mark)

2.16. Which one of the following statements is correct?

The force acting on an object is equivalent to

A its change of momentum.

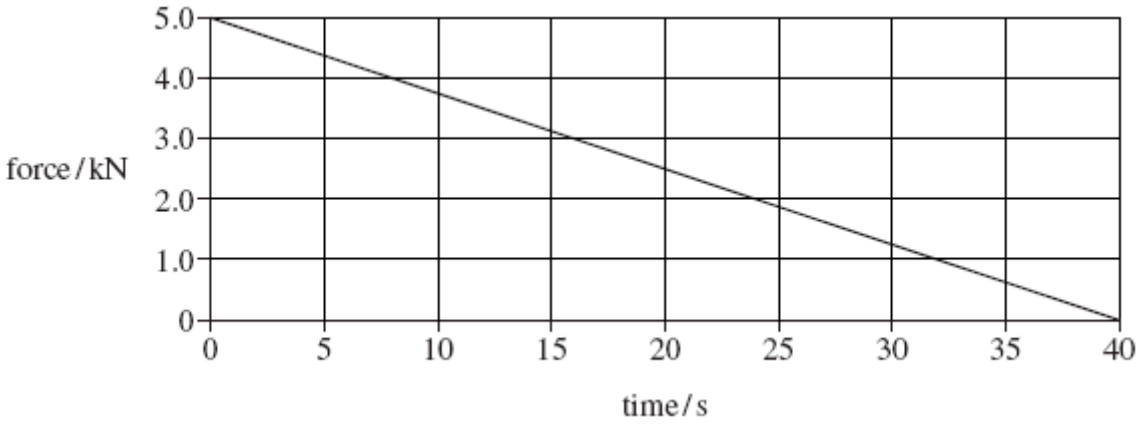
B the impulse it receives per second.

C the energy it gains per second.

D its acceleration per metre.

(Total 1 mark)

2.17. The graph shows how the force on a glider of mass 2000 kg changes with time as it is launched from a level track using a catapult.



Assuming the glider starts at rest what is its velocity after 40 s?

A 2.5 ms^{-1}

B 10 ms^{-1}

C 50 ms^{-1}

D 100 ms^{-1}

(Total 1 mark)

2.18. A gas molecule of mass *m* in a container moves with velocity *v*. If it makes an elastic collision at right angles to the walls of the container, what is the change in momentum of the molecule?

A zero

B *½ mv*

C *mv*

D *2 mv*

(Total 1 mark)

2.19. Water of density 1000 kgm^{-3} flows out of a garden hose of cross-sectional area 7.2×10^{-4} m^2 at a rate of 2.0×10^{-4} m^3 per second. How much momentum is carried by the water leaving the hose per second?

A 5.6×10^{-5} Ns

B 5.6×10^{-2} Ns

C 0.20 Ns

D 0.72 Ns

(Total 1 mark)

2.20. Which row, **A** to **D**, in the table correctly shows the quantities conserved in an inelastic collision?

	mass	**momentum**	**kinetic energy**	**total energy**
A	conserved	not conserved	conserved	conserved
B	not conserved	conserved	conserved	not conserved
C	conserved	conserved	conserved	conserved
D	conserved	conserved	not conserved	conserved

(Total 1 mark)

2.21. For the two physical quantities, impulse and force, which one of the following is correct?

A Impulse is a scalar and force is a scalar.

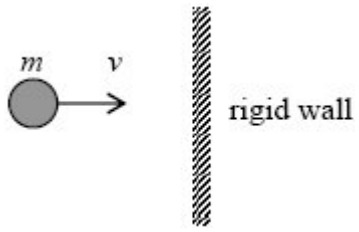
B Impulse is a scalar and force is a vector.

C Impulse is a vector and force is a scalar.

D impulse is a vector and force is a vector.

(Total 1 mark)

2.22. A particle of mass *m* strikes a rigid wall perpendicularly from the left with velocity *v*.



If the collision is perfectly elastic, the change in momentum of the particle which occurs as a result of the collision is

A 2*mv* to the right.

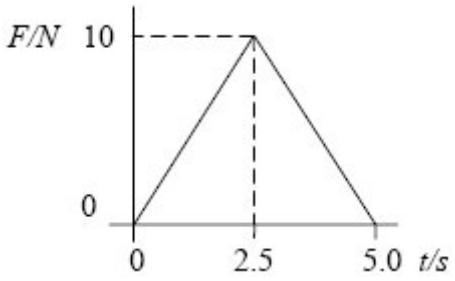
B 2*mv* to the left.

C *mv* to the left.

D zero.

(Total 1 mark)

2.23. A force, *F*, varies with time, *t*, as shown by the graph and is applied to a body initially at rest on a smooth surface.



What is the momentum of the body after 5.0 s?

A zero.

B 12.5 Ns.

C 25 Ns.

D 50 Ns.

(Total 1 mark)

2.24. The rate of change of momentum of a body falling freely under gravity is equal to its

A weight.

B power.

C kinetic energy.

D potential energy.

(Total 1 mark)

2.25. Which one of the following is a possible unit of impulse?

A Ns^{-1}

B $kgms^{-1}$

C $kgms^{-2}$

D sN^{-1}

(Total 1 mark)

2.26. A body falls freely, with negligible air resistance. What quantity of the body is its rate of change of momentum?

A mass

B power

C kinetic energy

D weight

(Total 1 mark)

2.27. Take the acceleration due to gravity, g_E, as 10 ms^{-2} on the surface of the Earth.

The acceleration due to gravity on the surface of the Moon is $\frac{g_E}{6}$. An object whose weight on Earth is 5.0 N is dropped from rest above the Moon's surface. What is its momentum after falling for 3.0s?

A 2.5 $kgms^{-1}$

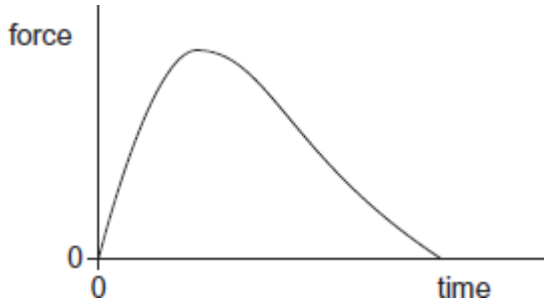
B 6.2 $kgms^{-1}$

C 15 $kgms^{-1}$

D 25 $kgms^{-1}$

(Total 1 mark)

2.28. The graph shows how the force acting on a rocket varies with time.



Which one of the following is represented by the area under the graph?

A distance travelled

B gain in kinetic energy

C change in velocity

D change in momentum

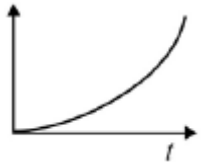
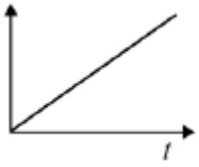
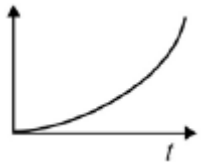
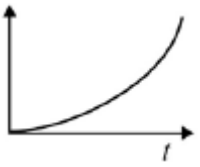
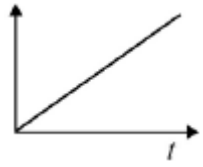
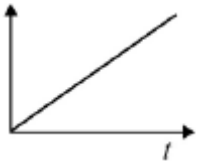
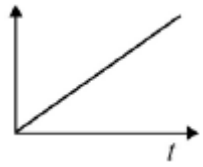
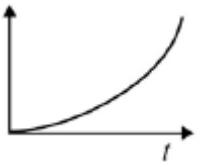
(Total 1 mark)

2.29. A firework rocket is fired vertically into the air and explodes at its highest point. What are the changes to the total kinetic energy of the rocket and the total momentum of the rocket as a result of the explosion?

	total kinetic energy of rocket	**total momentum of rocket**
A	unchanged	unchanged
B	unchanged	increased
C	increased	unchanged
D	increased	increased

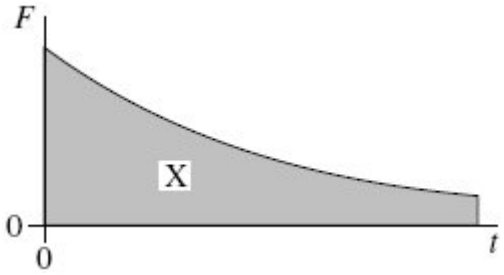
(Total 1 mark)

2.30. An object is accelerated from rest by a constant force *F* for a time *t*. Which graphs represent the variation of time with the change in the kinetic energy and the change in momentum of the object?

	Kinetic energy	**Momentum**
A		
B		
C		
D		

(Total 1 mark)

2.31. The graph shows the variation with time, *t*, of the force, *F*, acting on a body.



What physical quantity does the area X represent?

A the displacement of the body

B the acceleration of the body

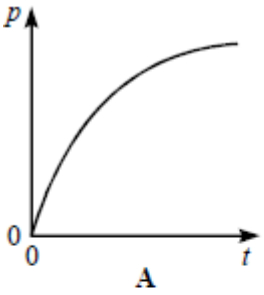
C the change in momentum of the body

D the change in kinetic energy of the body

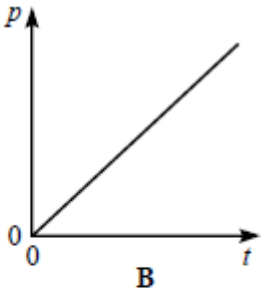
(Total 1 mark)

2.32. A body is accelerated from rest by a constant force.

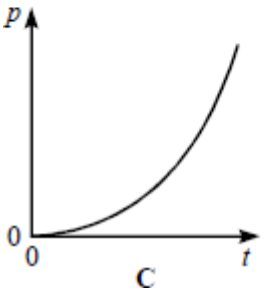
Which one of the following graphs best represents the variation of the body's momentum *p* with time *t*?



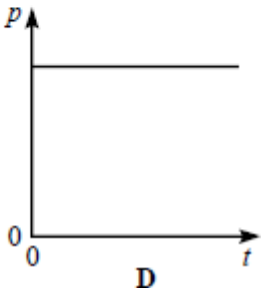
A



B



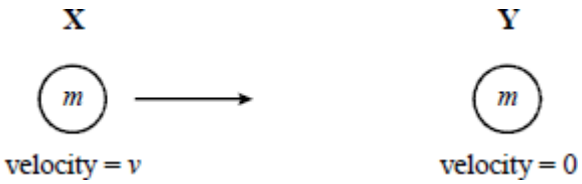
C



D

(Total 1 mark)

2.33. A body **X**, moving with a velocity v, collides elastically with a stationary body **Y** of equal mass.

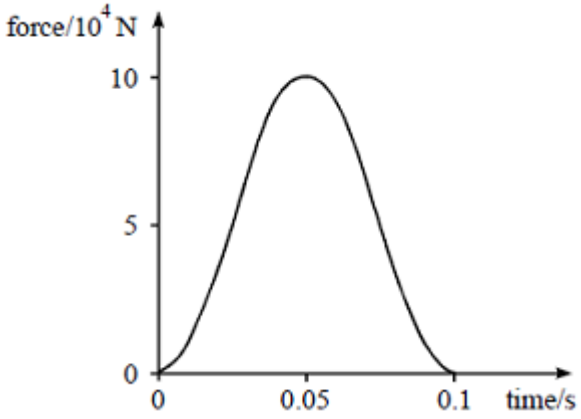


Which one of the following correctly describes the velocities of the two bodies after the collision?

	velocity of **X**	velocity of **Y**
A	$\frac{v}{2}$	$\frac{v}{2}$
B	$-\frac{v}{2}$	$\frac{v}{2}$
C	0	v
D	$-v$	0

(Total 1 mark)

2.34. The diagram shows the graph of force on a car against time when the car of mass 500 kg crashes into a wall without rebounding.



Which one of the following statements is correct?

A The area under the graph is equal to the initial momentum of the car

B Momentum is not conserved in the collision

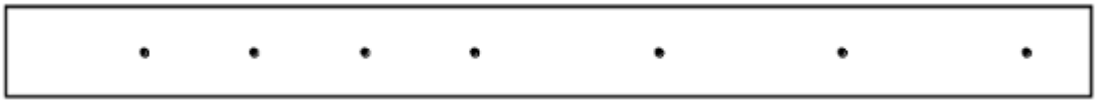
C Kinetic energy is conserved in the collision

D The average force exerted on the car is 10×10^4 N

(Total 1 mark)

2.35. The diagram shows a strobe photograph of a mark on a trolley **X**, moving from right to left, in collision with another trolley **Y** which had no mark on it.

After the collision both trolleys are in motion together.



Which **one** of the following is consistent with the photograph?

A Trolley **Y** has the same mass as trolley **X** and was initially stationary

B Trolley **Y** had a smaller mass than **X** and was moving from right to left

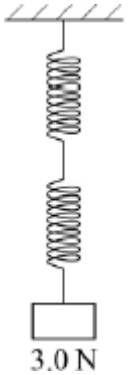
C Trolley **Y** had the same mass and was initially moving left to right at the same speed as trolley **X**

D Trolley **Y** had the same mass and was initially moving left to right at a higher speed than trolley **X**

(Total 1 mark)

SECTION 3

3.1. A load of 3.0 N is attached to a spring of negligible mass and spring constant 15 N m^{-1}.



What is the energy stored in the spring?

A 0.3 J

B 0.6 J

C 0.9 J

D 1.2 J

(Total 1 mark)

3.2. A stone is projected horizontally by a catapult consisting of two rubber cords. The cords, which obey Hooke's law, are stretched and released. When each cord is extended by x, the stone is projected with a speed v.

Assuming that all the strain energy in the rubber is transferred to the stone, what is the speed of the stone when each cord is extended by $2x$?

A v

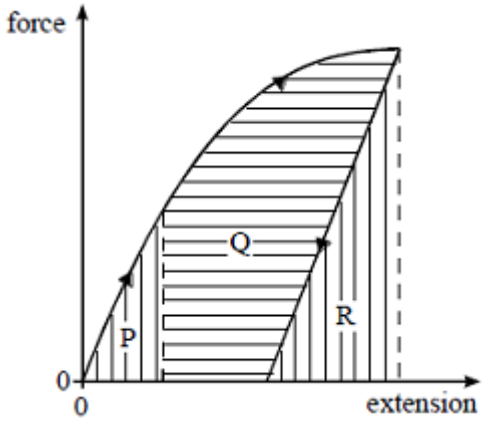
B $\sqrt{2v}$

C $2v$

D $4v$

(Total 1 mark)

3.3. The force on a sample of a material is gradually increased and then decreased. The graph of force against extension is shown in the diagram.



The increase in thermal energy in the sample is represented by area

A R

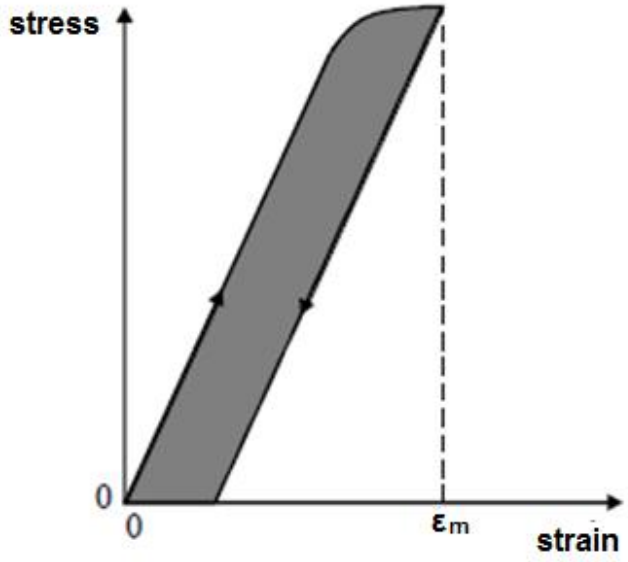
B P + Q

C P + Q + R

D P + Q - R

(Total 1 mark)

3.4. The graph shows the variation of stress with strain for a ductile alloy when a specimen is slowly stretched to a maximum strain of ε_m and the stress is then slowly reduced to zero.



The shaded area

A represents the work done per unit volume when stretching the specimen

B represents the energy per unit volume recovered when the stress is removed

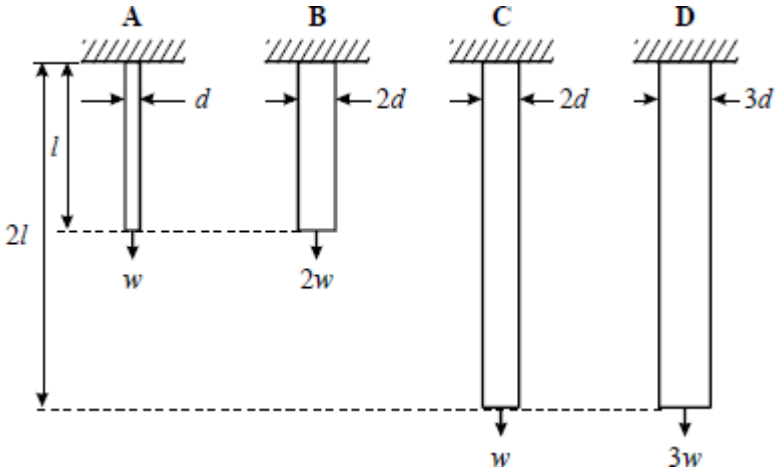
C represents the energy per unit volume which cannot be recovered

D has units of J m^{-1}

(Total 1 mark)

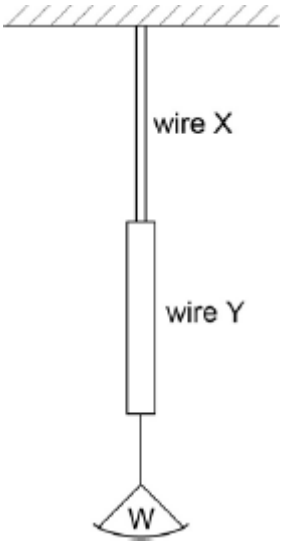
3.5. The four bars **A**, **B**, **C** and **D** have diameters, lengths and loads as shown. They are all made of the same material.

Which bar has the greatest extension?



(Total 1 mark)

3.6. Two vertical copper wires X and Y of equal length are joined as shown. Y has a greater diameter than X. A weight W is hung from the lower end of Y.



Which of the following is correct?

A The strain in X is the same as that in Y.

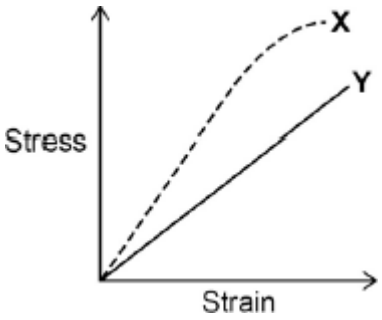
B The stress in Y is greater than that in X.

C The tension in Y is the same as that in X.

D The elastic energy stored in X is less than that stored in Y.

(Total 1 mark)

3.7. The diagram shows how the stress varies with strain for metal specimens X and Y which are different. Both specimens were stretched until they broke.



Which of the following is incorrect?

A X is stiffer than Y

B X has a higher value of the Young modulus

C X is more brittle than Y

D Y has a lower maximum tensile stress than X

(Total 1 mark)

SECTION 4

4.1. When comparing X-rays with UV radiation, which statement is correct?

A X-rays have a lower frequency.

B X-rays travel faster in a vacuum.

C X-rays do not show diffraction and interference effects.

D Using the same element, photoelectrons emitted using X-rays have the greater maximum kinetic energy.

(Total 1 mark)

4.2. Sound waves cross a boundary between two media X and Y. The frequency of the waves in X is 400 Hz. The speed of the waves in X is 330 ms^{-1} and the speed of the waves in Y is 1320 ms^{-1}. What are the correct frequency and wavelength in Y?

	Frequency / Hz	**Wavelength / m**
A	100	0.82
B	400	0.82
C	400	3.3
D	1600	3.3

(Total 1 mark)

4.3. Which of the following statements is true for a stationary wave?

A Between two nodes the amplitude of the wave is constant.

B The two waves producing the stationary wave must always be 180° out of phase.

C The separation of the nodes for the second harmonic is double the separation of nodes for the first harmonic.

D Between two nodes all parts of the wave vibrate in phase.

(Total 1 mark)

4.4. A light source emits light which is a mixture of two wavelength, λ_1 and λ_2. When the light is incident on a diffraction grating it is found that the fifth order of light of wavelength λ_1 occurs at the same angle as the fourth order for light of wavelength λ_2. If λ_1 is 480 nm what is λ_2?

A 400 nm

B 480 nm

C 600 nm

D 750 nm

(Total 1 mark)

4.5. A diffraction pattern is formed by passing monochromatic light through a single slit. If the width of the single slit is reduced, which of the following is true?

	Width of central maximum	**Intensity of central maximum**
A	unchanged	decreases
B	increases	increases
C	increases	decreases
D	decreases	decreases

(Total 1 mark)

4.6. Which of the following waves **cannot** be polarised?

A radio

B ultrasonic

C microwave

D ultraviolet

(Total 1 mark)

4.7. Two points on a progressive wave are one-eighth of a wavelength apart. The distance between them is 0.5 m, and the frequency of the oscillation is 10 Hz. What is the minimum speed of the wave?

A 0.2 ms^{-1}

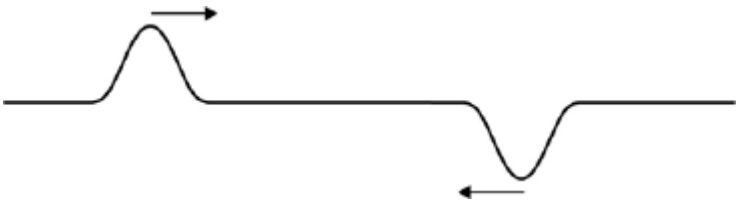
B 10 ms^{-1}

C 20 ms^{-1}

D 40 ms^{-1}

(Total 1 mark)

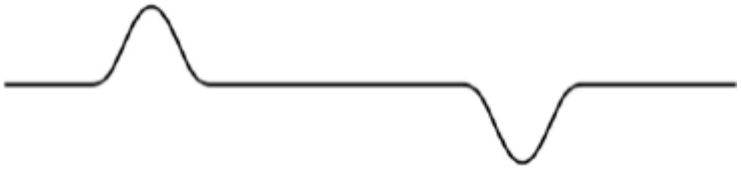
4.8. The diagram shows two pulses on a string travelling towards each other.



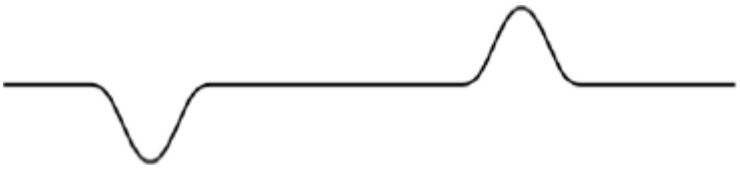
Which of the following diagrams shows the shape of the string when the pulses have passed through each other?

A

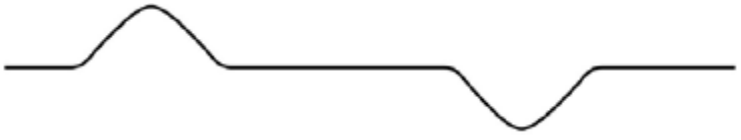
B



C



D



(Total 1 mark)

4.9. Monochromatic light may be characterised by its speed, frequency and wavelength. Which of the following quantities change when monochromatic light passes from air into glass?

A Speed only

B Speed and wavelength only

C Speed and frequency only

D Wavelength and frequency only

(Total 1 mark)

4.10. Monochromatic light of wavelength 490 nm falls normally on a diffraction grating that has 6×10^5 lines per metre. Which one of the following is correct?

A The first order is observed at angle of diffraction of 17°.

B The second order is observed at angle of diffraction of 34°.

C The third and higher orders are not produced.

D A grating with more lines per metre could produce more orders.

(Total 1 mark)

4.11. Which one of the following provides direct experimental evidence that light is a transverse wave motion rather than a longitudinal wave motion?

A Two light waves that are coherent can be made to interfere.

B Light can be diffracted.

C Light can be polarised.

D The intensity of light from a point source falls off inversely as the square of the distance from the source.

(Total 1 mark)

4.12. A stationary wave is formed by two identical waves of frequency 300 Hz travelling in opposite directions along the same line. If the distance between adjacent nodes is 0.60 m, what is the speed of each wave?

A 180 ms^{-1}

B 250 ms^{-1+}

C 360 ms^{-1}

D 500 ms^{-1}

(Total 1 mark)

4.13. By approximately how many times is the wavelength of audible sound waves greater than the wavelength of light waves?

A 10^2

B 10^6

C 10^{10}

D 10^{14}

(Total 1 mark)

4.14. Two points on a progressive wave differ in phase by $\frac{\pi}{4}$. The distance between them is 0.5 m, and the frequency of the oscillation is 10 Hz.

What is the minimum speed of the wave?

A 0.2 ms^{-1}

B 10 ms^{-1}

C 20 ms^{-1}

D 40 ms^{-1}

(Total 1 mark)

4.15. Which line, **A** to **D**, in the table gives a correct difference between a progressive wave and a stationary wave?

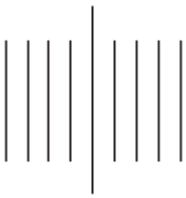
	progressive wave	**stationary wave**
A	all the particles vibrate	some of the particles do not vibrate
B	none of the particles vibrate with the same amplitude	all the particles vibrate with the same amplitude
C	all the particles vibrate in phase with each other	none of the particles vibrate in phase with each other
D	some of the particles do not vibrate	all the particles vibrate in phase with each other

(Total 1 mark)

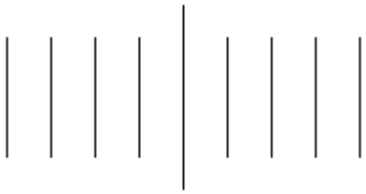
4.16. The diagram shows the first four diffraction orders each side of the zero order when a beam of monochromatic light is incident normally on a diffraction grating of slit separation d. All the angles of diffraction are small.

Which one of the patterns, **A** to **D**, drawn on the same scale, is obtained when the grating is exchanged for one with a slit separation $\frac{d}{2}$?

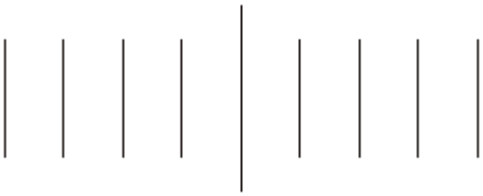
A



B



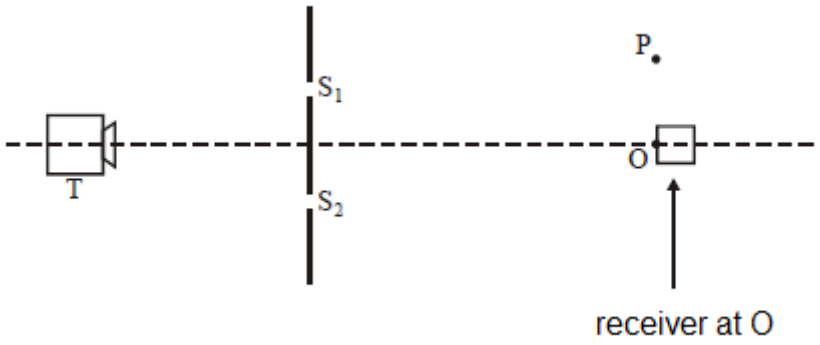
C



D

(Total 1 mark)

4.17. The diagram shows a microwave transmitter T which directs microwaves of wavelength meet two slits S_1 and S_2 formed by metal plates. The microwaves that pass through the two slits are detected by a receiver.



When the receiver is moved to P from O, which is equidistant from S_1 and S_2, the signal received decreases from a maximum to a minimum. Which one of the following statements is a correct deduction from this observation?

A The path difference $S_1O - S_2O = 0.5\,\lambda$

B The path difference $S_1O - S_2O = \lambda$

C The path difference $S_1P - S_2P = 0.5\,\lambda$

D The path difference $S_1P - S_2P = \lambda$

(Total 1 mark)

4.18. Stationary waves are set up on a length of rope fixed at both ends. Which one of the following statements is true?

A Between adjacent nodes, particles of the rope vibrate in phase with each other.

B The midpoint of the rope is always stationary.

C Nodes need not necessarily be present at each end of the rope.

D Particles of the rope at adjacent antinodes always move in the same direction.

(Total 1 mark)

4.19. Light of wavelength λ is incident normally on a diffraction grating of slit separation 4λ. What is the angle between the second order maximum and third order maximum?

A 14.5°

B 18.6°

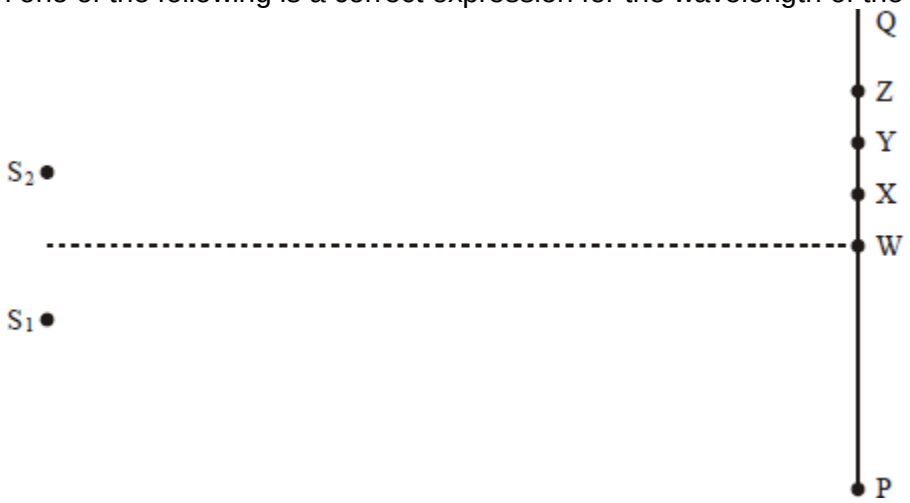
C 48.6°

D 71.4°

(Total 1 mark)

4.20. Point sources of sound of the same frequency are placed at S_1 and S_2. When a sound detector is slowly moved along the line PQ, consecutive maxima of sound intensity are detected at W and Y and consecutive minima at X and Z.

Which one of the following is a correct expression for the wavelength of the sound?



A $S_1X - S_1W$

B $S_1Y - S_1X$

C $S_1X - S_2X$

D $S_1Y - S_2Y$

(Total 1 mark)

4.21. In a Young's double slit interference experiment, monochromatic light placed behind a single slit illuminates two narrow slits and the interference pattern is observed on a screen placed some distance away from the slits. Which one of the following **decreases** the separation of the fringes?

A increasing the width of the single slit

B decreasing the separation of the double slits

C increasing the distance between the double slits and the screen

D using monochromatic light of higher frequency

(Total 1 mark)

4.22. Monochromatic light of wavelength 590 nm is incident normally on a plane diffraction grating having 4×10^5 lines m^{-1}. An interference pattern is produced. What is the highest order visible in this interference pattern?

A 2

B 3

C 4

D 5

(Total 1 mark)

4.23. A wave of frequency 5 Hz travels at 8 km s^{-1} through a medium. What is the phase difference, in radians, between two points 2 km apart?

A 0

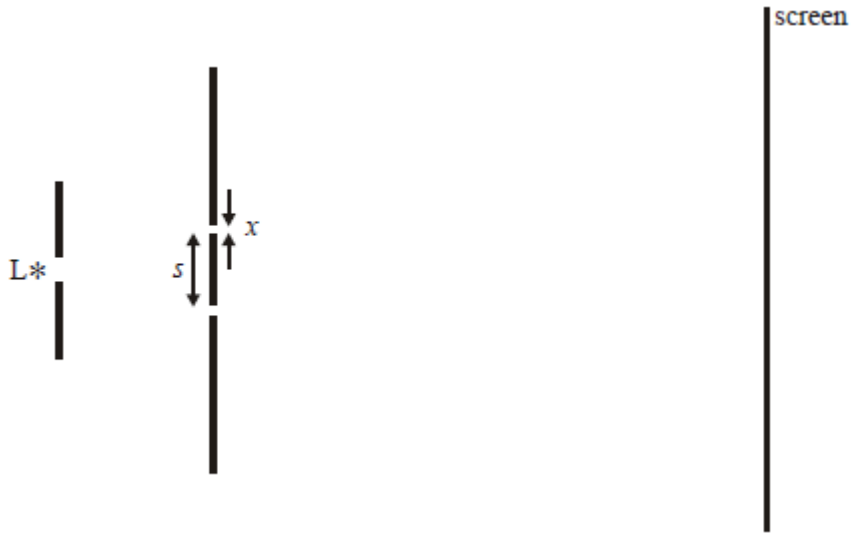
B $\frac{\pi}{2}$

C π

D $\frac{3\pi}{2}$

(Total 1 mark)

4.24. In a double slit system used to produce interference fringes, the separation of the slits is s and the width of each slit is x. L is a source of monochromatic light.



Which one of the following changes would **decrease** the separation of the fringes seen on the screen?

A moving the screen closer to the double slits

B decreasing the width, x, of each slit, but keeping s constant

C decreasing the separation, s, of the slits

D exchanging L for a monochromatic source of longer wavelength

(Total 1 mark)

4.25. Interference maxima produced by a double source are observed at a distance of 1.0 m from the sources. In which one of the following cases are the maxima closest together?

A red light of wavelength 700 nm from sources 4.0 mm apart

B sound waves of wavelength 20 mm from sources 50 mm apart

C blue light of wavelength 450 nm from sources 2.0 mm apart

D surface water waves of wavelength 10 mm from sources 200 mm apart

(Total 1 mark)

4.26. The diagram shows a snapshot of a wave on a rope travelling from left to right.

At the instant shown, point **P** is at maximum displacement and point **Q** is at zero displacement.
Which one of the following lines, **A** to **D**, in the table correctly describes the motion of **P** and **Q** in the next half-cycle?

	P	**Q**
A	falls then rises	rises
B	falls then rises	rises then falls
C	falls	falls
D	falls	rises then falls

(Total 1 mark)

4.27. The least distance between two points of a progressive transverse wave which have a phase difference of $\frac{\pi}{3}$ rad is 0.050 m. If the frequency of the wave is 500 Hz, what is the speed of the wave?

A 25 ms^{-1}

B 75 ms^{-1}

C 150 ms^{-1}

D 1666 ms^{-1}

(Total 1 mark)

4.28. In a Young's double slits interference arrangement the fringe separation is s when the wavelength of the radiation is λ, the slit separation w and the distance between the slits and the plane of the observed fringes D. In which one of the following cases would the fringe separation also be s?

	wavelength	**slit separation**	**distance between slits and fringes**
A	2λ	$2w$	$2D$
B	2λ	$4w$	$2D$
C	2λ	$2w$	$4D$
D	4λ	$2w$	$2D$

(Total 1 mark)

4.29. Which one of the following statements about stationary waves is true?

A Particles between adjacent nodes all have the same amplitude.

B Particles between adjacent nodes are out of phase with each other.

C Particles immediately on either side of a node are moving in opposite directions.

D There is minimum disturbance of the medium at an antinode.

(Total 1 mark)

4.30. Young's two slit interference pattern with red light of wavelength 7.0×10^{-7} m gives a fringe separation of 2.0 mm.

What separation, in mm, would be observed at the same place using blue light of wavelength 4.5×10^{-7} m?

A 0.65

B 1.3

C 2.6

D 3.1

(Total 1 mark)

4.31a and 4.31b

Figures **1** and **2** each show a ray of light incident on a water-air boundary. **A, B, C** and **D** show ray directions at the interface.

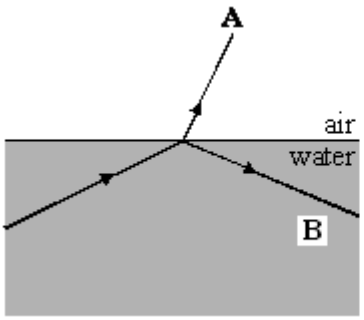


Figure 1

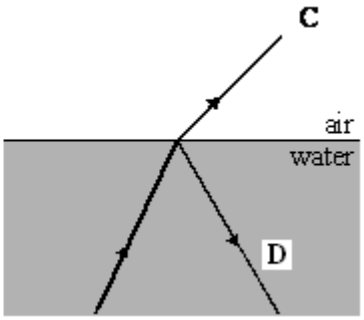


Figure 2

4.31a Circle the letter below that corresponds to a direction in which a ray **cannot** occur.

A **B** **C** **D**

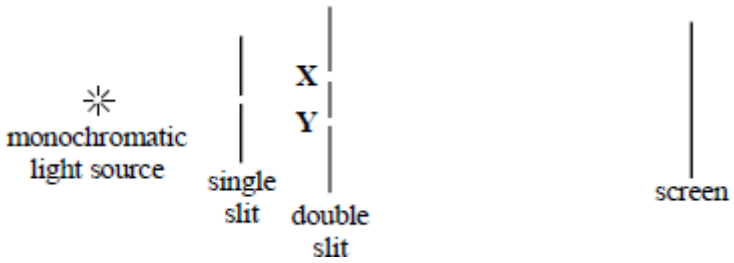
(1)

4.31b Circle the letter below that corresponds to the direction of the faintest ray.

A **B** **C** **D**

(1)
(Total 2 marks)

4.32. The diagram represents the experimental arrangement used to produce interference fringes in Young's double slit experiment.



The spacing of the fringes on the screen will increase if

A the width of the single slit is increased

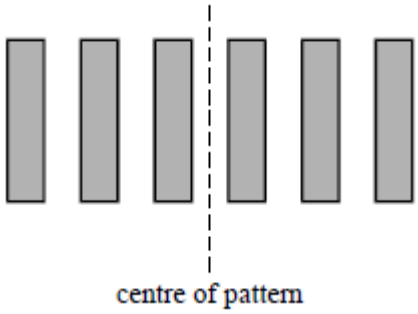
B the distance **XY** between the two slits is increased

C a light source of lower frequency is used

D the distance between the single and double slits is decreased

(Total 1 mark)

4.33.



A double slit interference experiment is performed using monochromatic light of wavelength λ. The centre of the observed pattern is a bright fringe. What is the path difference between two waves which interfere to give the third dark fringe from the centre?

A 0.5 λ

B 1.5 λ

C 2.5 λ

D 3.5 λ

(Total 1 mark)

4.34. Two waves with amplitudes a and $3a$ interfere.

The ratio $\frac{\text{amplitude at an interference maximum}}{\text{amplitude at an interference minimum}}$ is

A 2

B 3

C 4

D infinity

(Total 1 mark)

4.35. A progressive wave in a stretched string has a speed of 20 ms^{-1} and a frequency of 100 Hz.
What is the phase difference between two points 25 mm apart?

A zero

B $\frac{\pi}{4}$ rad

C $\frac{\pi}{2}$ rad

D π rad

(Total 1 mark)

4.36. Using a diffraction grating with monochromatic light of wavelength 500 nm incident normally, a student found the 2nd order diffracted maxima in a direction at 30° to the central bright fringe. What is the number of lines per metre on the grating?

A 2×10^4

B 2×10^5

C 4×10^5

D 5×10^5

(Total 1 mark)

4.37. In a double slit interference arrangement the fringe spacing is w when the wavelength of the radiation is λ, the distance between the double slits is s and the distance between the slits and the plane of the observed fringes is D. In which one of the following cases would the fringe spacing also be w?

	wavelength	**distance between slits**	**distance between slits and fringes**
A	2λ	$2s$	$2D$
B	2λ	$4s$	$2D$
C	2λ	$2s$	$4D$
D	4λ	$2s$	$2D$

(Total 1 mark)

4.38. Which one of the following statements about stationary waves is true?

A Particles between adjacent nodes all have the same amplitude.

B Particles between adjacent nodes are out of phase with each other.

C Particles immediately on either side of a node are moving in opposite directions.

D There is a minimum disturbance of the medium at an antinode.

(Total 1 mark)

4.39. Which one of the following types of wave **cannot** be polarised?

A radio

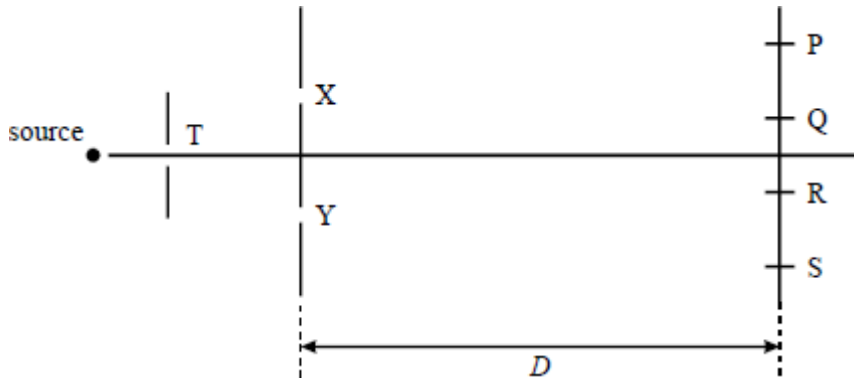
B ultrasonic

C microwave

D ultraviolet

(Total 1 mark)

4.40.



Coherent monochromatic light of wavelength λ emerges from the slits X and Y to form dark fringes at P, Q, R and S in a double slit apparatus.
Which one of the following statements is true?

A When the distance D is increased, the separation of the fringes increases.

B When the distance between X and Y is increased, the separation of the fringes increases.

C When the width of the slit T is decreased, the separation of the fringes decreases.

D There is a dark fringe at P because (YP − XP) is 2λ.

(Total 1 mark)

4.41. A wave motion has period T, frequency f, wavelength λ and speed v. Which one of the following equations is **incorrect**?

A $1 = Tf$

B $T = \frac{v}{\lambda}$

C $\lambda = \frac{v}{f}$

D $Tv = \lambda$

(Total 1 mark)

4.42. A uniform wire fixed at both ends is vibrating in its fundamental mode. Which one of the following statements is **not** correct for all the vibrating particles?

A They vibrate in phase.

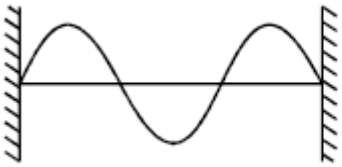
B They vibrate with the same amplitude.

C They vibrate with the same frequency.

D They vibrate at right angles to the wire.

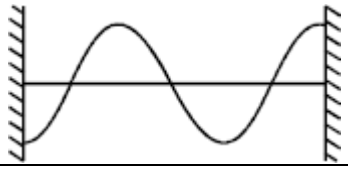
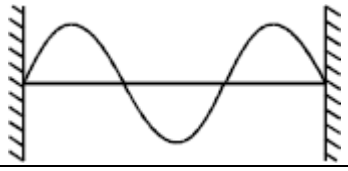
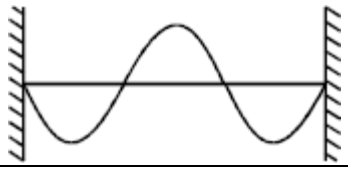
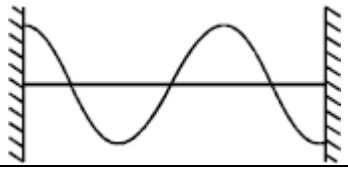
(Total 1 mark)

4.43. The diagram shows a stationary wave on a stretched string at a time $t = 0$



frequency of vibration = 50 Hz

Which one of the diagrams, **A** to **D**, correctly shows the position of the string at a time $t = 0.010$ s?

A	
B	
C	
D	

(Total 1 mark)

SECTION 5

5.1. What are the numbers of hadrons, baryons and mesons in an atom of $^{7}_{3}\mathrm{Li}$?

	hadrons	**baryons**	**mesons**
A	7	3	3
B	7	4	4
C	7	7	0
D	10	7	0

(Total 1 mark)

5.2. Electron capture can be represented by the following equation.

$$p + e^{-} \rightarrow X + Y$$

Which row correctly identifies **X** and **Y**?

	X	**Y**
A	p	K^{-}
B	e^{-}	e^{+}
C	n	ν_e
D	n	π^{0}

(Total 1 mark)

5.3. A calcium ion is formed by removing two electrons from an atom of $^{40}_{20}\mathrm{Ca}$. What is the specific charge of the calcium ion?

A 3.2×10^{-19} C kg^{-1}

B 2.9×10^{-18} C kg^{-1}

C 4.8×10^{6} C kg^{-1}

D 4.8×10^{7} C kg^{-1}

(Total 1 mark)

5.4. Electrons and protons in two beams are travelling at the same speed. The beams are diffracted by objects of the same size.

Which correctly compares the de Broglie wavelength λ_e of the electrons with the de Broglie wavelength λ_p of the protons and the width of the diffraction patterns that are produced by these beams?

	comparison of de Broglie wavelength	diffraction pattern
A	$\lambda_e > \lambda_p$	electron beam width > proton beam width
B	$\lambda_e < \lambda_p$	electron beam width > proton beam width
C	$\lambda_e > \lambda_p$	electron beam width < proton beam width
D	$\lambda_e < \lambda_p$	electron beam width < proton beam width

(Total 1 mark)

5.5. Which of the following is **not** true?

A Each meson consists of a single quark and a single antiquark.

B Each baryon consists of three quarks.

C The magnitude of the charge on every quark is $\frac{1}{3}$

D A particle consisting of a single quark has not been observed.

(Total 1 mark)

5.6. The nucleus of $^{9}_{4}\mathrm{Be}$ captures a proton and emits an α particle. What is the product nucleus?

A $^{10}_{6}\mathrm{C}$

B $^{7}_{3}\mathrm{Li}$

C $^{6}_{3}\mathrm{Li}$

D $^{6}_{2}\mathrm{He}$

(Total 1 mark)

5.7. An electron collides with a neutral atom and ionizes it. Which of the following describes the particles present after the collision?

A An electron and an excited atom.

B An excited atom containing an excess electron.

C Two electrons and a positive ion.

D Two electrons and a neutral atom in the ground state.

(Total 1 mark)

5.8. In a nuclear reaction $^{14}_{7}\mathrm{N}$ is bombarded by neutrons. This results in the capture of one neutron and the emission of one proton by one nucleus of $^{14}_{7}\mathrm{N}$. The resulting nucleus is

A $^{13}_{7}\mathrm{N}$

B $^{14}_{6}\mathrm{C}$

C $^{12}_{6}\mathrm{C}$

D $^{14}_{8}\mathrm{O}$

(Total 1 mark)

5.9. A radioactive nucleus emits a β^- particle then an α particle and finally another β^- particle. The final nuclide is

A an isotope of the original element

B the same element with a different proton number

C a new element of higher proton number

D a new element of lower nucleon number

(Total 1 mark)

5.10. When comparing X-rays with UV radiation, which statement is correct?

A X-rays have a lower frequency.

B X-rays travel faster in a vacuum.

C X-rays do not show diffraction and interference effects.

D Using the same element, photoelectrons emitted using X-rays have the greater maximum kinetic energy.

(Total 1 mark)

5.11. The intensity of a monochromatic light source is increased. Which of the following is correct?

	Energy of an emitted photon	Number of photons emitted per second
A	increases	increases
B	increases	unchanged
C	unchanged	increases
D	unchanged	unchanged

(Total 1 mark)

5.12. Monochromatic radiation from a source of light (source A) is shone on to a metallic surface and electrons are emitted from the surface. When a second source (source B) is used no electrons are emitted from the metallic surface. Which property of the radiation from source A must be greater than that from source B?

A amplitude

B frequency

C intensity

D wavelength

(Total 1 mark)

5.13. An electron has a kinetic energy E and a de Broglie wavelength λ. The kinetic energy is increased to $4E$. What is the new de Broglie wavelength?

A $\frac{\lambda}{4}$

B $\frac{\lambda}{2}$

C λ

D 4λ

(Total 1 mark)

5.14. In a photoelectric experiment, light is incident on the metal surface of a photocell. Increasing the intensity of the illumination at the surface leads to an increase in the

A work function

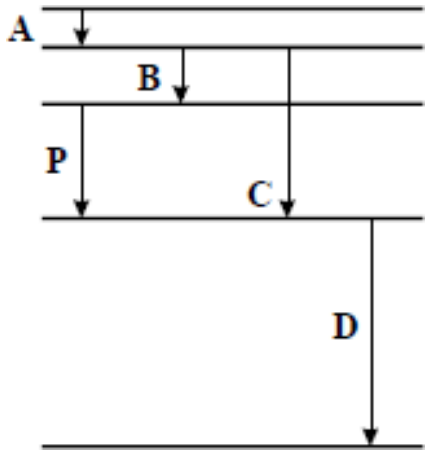
B minimum frequency at which electrons are emitted

C current through the photocell

D speed of the electrons

(Total 1 mark)

5.15. The diagram **drawn to scale** shows some of the energy levels of an atom. Transition **P** results in the emission of a photon of wavelength 4×10^{-7} m.



Which one of the transitions **A**, **B**, **C**, or **D** could result in the emission of a photon of wavelength 8×10^{-7} m?

(Total 1 mark)

5.16. An electron initially at rest is accelerated through a potential difference. It is then brought to rest in a collision, and all of its kinetic energy is converted into a single photon of electromagnetic radiation. Which one of the following quantities is **not** required to find a value for the wavelength of the photon?

A The mass of the electron

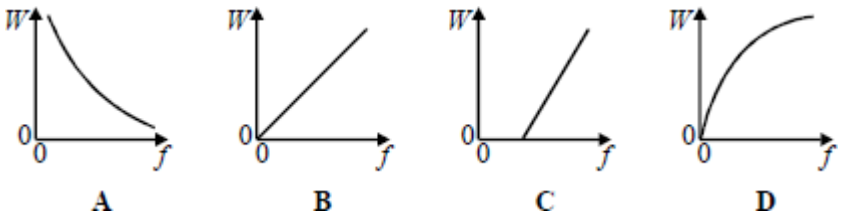
B The charge on the electron

C The velocity of electromagnetic waves

D The value of the potential difference

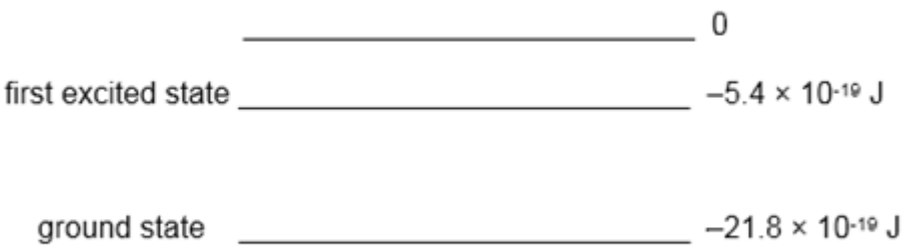
(Total 1 mark)

5.17. Which one of the graphs best represents the relationship between the energy W of a photon and the frequency f of the radiation?



(Total 1 mark)

5.18. The diagram shows some of the energy levels for a hydrogen atom.



A free electron of kinetic energy 20.0×10^{-19} J collides with a hydrogen atom in its ground state. The hydrogen atom is excited from its ground state to the first excited state. The kinetic energy of the free electron after the collision is

A 1.8×10^{-19} J

B 3.6×10^{-19} J

C 5.4×10^{-19} J

D 16.4×10^{-19} J

(Total 1 mark)

SECTION 6

6.1. In a cathode ray tube 7.5×10^{15} electrons strike the screen in 40 s. What current does this represent?

Charge of the electron is 1.6×10^{-19} C.

A 1.3×10^{-16} A

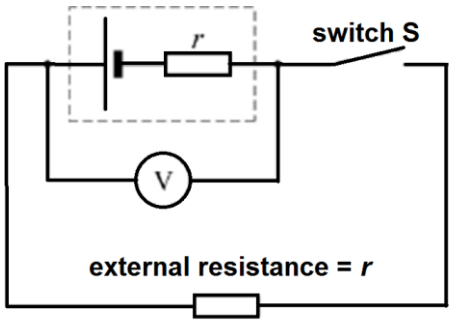
B 5.3×10^{-15} A

C 3.0×10^{-5} A

D 1.2×10^{-3} A

(Total 1 mark)

6.2. In the circuit shown, V is a voltmeter with a very high resistance. The internal resistance of the cell, r, is equal to the external resistance in the circuit.



Which of the following is not equal to the e.m.f. of the cell?

A the reading of the voltmeter when the Switch S is open

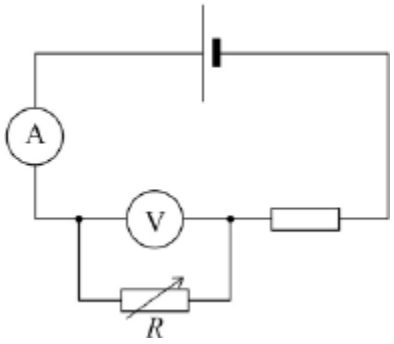
B the chemical energy changed to electrical energy when unit charge passes through the cell

C twice the reading of the voltmeter when the switch S is closed

D the electrical energy produced when unit current passes through the cell

(Total 1 mark)

6.3. In the circuit shown in the diagram the cell has negligible internal resistance.



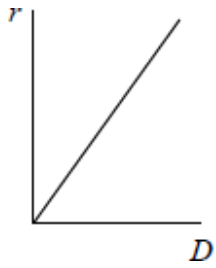
What happens to the reading of both meters when the resistance of R is decreased?

	Reading of ammeter	Reading of voltmeter
A	increases	increases
B	increases	decreases
C	decreases	increases
D	unchanged	decreases

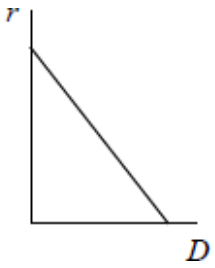
(Total 1 mark)

6.4. Which graph shows how the resistance per unit length *r* of a wire varies with diameter *D* of the wire?

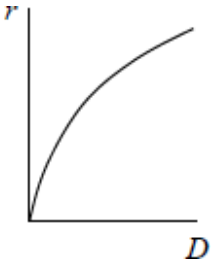
A



B



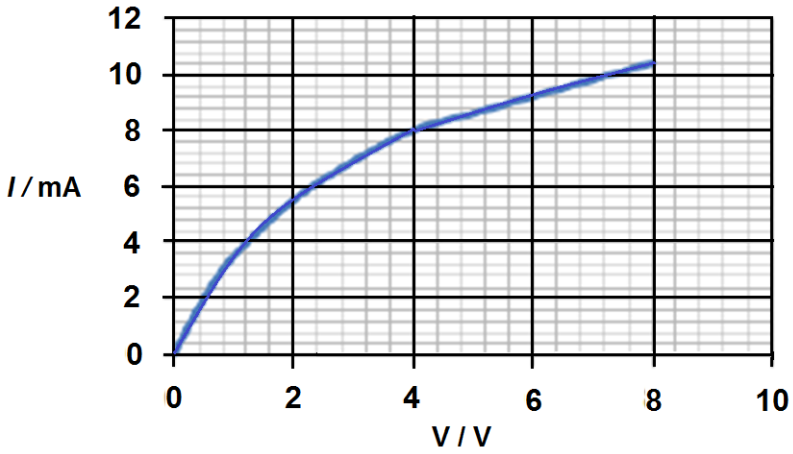
C



D

(Total 1 mark)

6.5. The graph shows the current–voltage (*I*–*V*) characteristics of a filament lamp.



What is the resistance of the filament when the potential difference across it is 4.0 V?

A 500 Ω

B 1700 Ω

C 2000 Ω

D 6000 Ω

(Total 1 mark)

6.6. An electric motor of input power 100 W raises a mass of 10 kg vertically at a steady speed of 0.5 ms^{-1}. What is the efficiency of the system?

A 5%

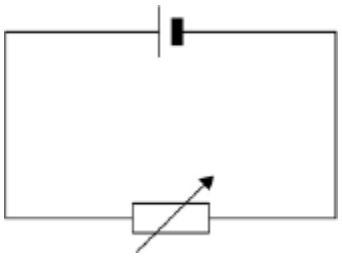
B 12%

C 50%

D 100%

(Total 1 mark)

6.7. The cell in the circuit has an e.m.f. of 2.0 V. When the variable resistor has a resistance of 4.0 Ω, the potential difference (p.d.) across the terminals of the cell is 1.0 V.



What is the p.d. across the terminals of the cell when the resistance of the variable resistor is 12 Ω?

A 0.25 V

B 0.75 V

C 1.33 V

D 1.50 V

(Total 1 mark)

6.8. A cylindrical conductor of length *l*, diameter *D*, and resistivity *ρ* has a resistance *R*. What is the resistance of another cylindrical conductor of length *l*, diameter $\frac{D}{2}$ and resistivity *ρ*?

A 8*R*

B 4*R*

C 2*R*

D *R*

(Total 1 mark)

6.9. The resistance of a negative temperature coefficient (ntc) thermistor

A increases as temperature increases.

B is constant at temperatures below 0 °C.

C increases as temperature decreases.

D falls to zero when a critical temperature is reached.

(Total 1 mark)

6.10. The unit of potential difference can be expressed as

A $C\ s^{-1}$

B $J\ C^{-1}$

C $V\ A^{-1}$

D $J\ A^{-1}$

(Total 1 mark)

6.11. A 1.5 m length of wire has a cross-sectional area $5.0 \times 10^{-8}\ m^2$. When the potential difference across its ends is 0.20 V, it carries a current of 0.40 A. The resistivity of the material from which the wire is made is

A $6.0 \times 10^{7}\ \Omega m$

B $1.7 \times 10^{-8}\ \Omega m$

C $1.1 \times 10^{6}\ \Omega m$

D $9.4 \times 10^{-7}\ \Omega m$

(Total 1 mark)

6.12. The circuit in **Figure 1** is used to investigate how the potential difference V between the terminals of a cell varies as the current I in the circuit changes. **Figure 2** shows the graph of the results.

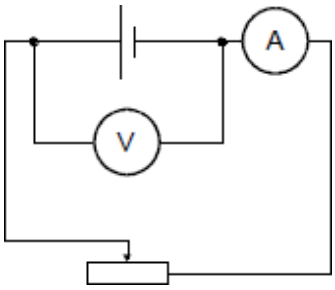


Figure 1

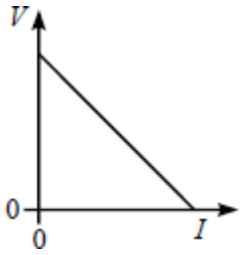


Figure 2

Which one of the following can be deduced from the gradient of the graph?

A The internal resistance of the cell

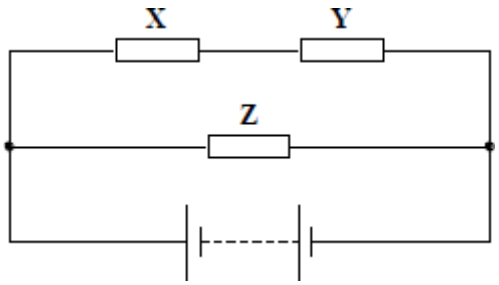
B The e.m.f. of the cell

C The power dissipated by the cell

D The resistance of the variable resistor

(Total 1 mark)

6.13. Three identical resistors **X**, **Y** and **Z** are connected across a battery as shown.



The ratio $\frac{\text{power developed in X}}{\text{power developed in Z}}$ is

A $\frac{1}{4}$

B $\frac{1}{2}$

C 1

D 2

(Total 1 mark)

6.14. Three identical cells, each of internal resistance *R*, are connected in series with an external resistor of resistance *R*. The current in the external resistor is *I*. If one of the cells is reversed in the circuit, what is the new current in the external resistor?

A $\frac{I}{3}$

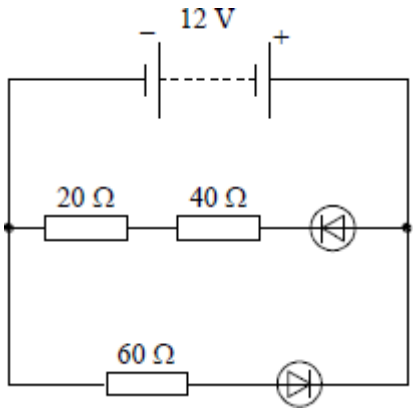
B $\frac{4I}{9}$

C $\frac{I}{2}$

D $\frac{2I}{3}$

(Total 1 mark)

6.15. The 12 V battery in the circuit shown has negligible internal resistance. The diodes have 'ideal' characteristics.



The current through the battery is approximately

A 0 A

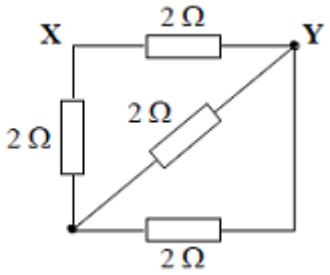
B 0.10 A

C 0.20 A

D 0.40 A

(Total 1 mark)

6.16. The diagram shows a network of four 2 Ω resistors.



The effective resistance, in Ω, between **X** and **Y** is

A 0.5

B 1.2

C 1.7

D 2.0

(Total 1 mark)

6.17. Copper metal is a good conductor of electricity because copper atoms in copper metal

A have gained an extra or “free” electron

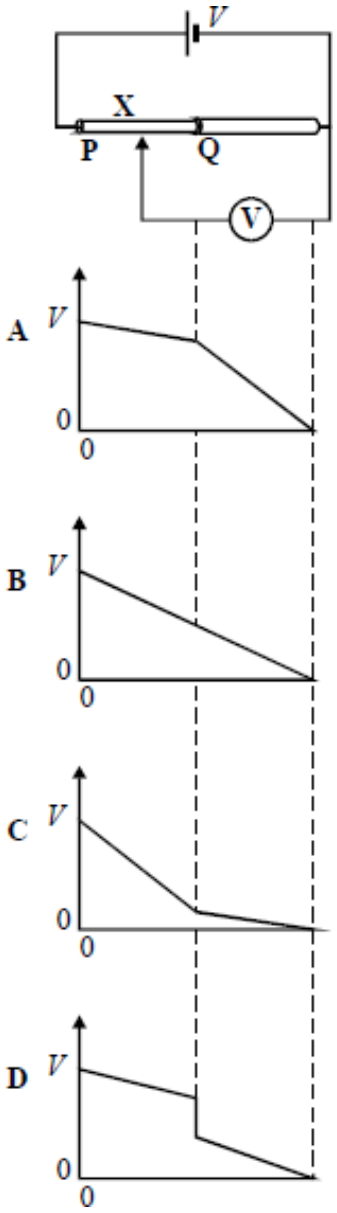
B are ionised so that both ions and “free” electrons can move

C have a negative charge because of the “free” electrons

D have lost an electron to form positive ions and “free” electrons

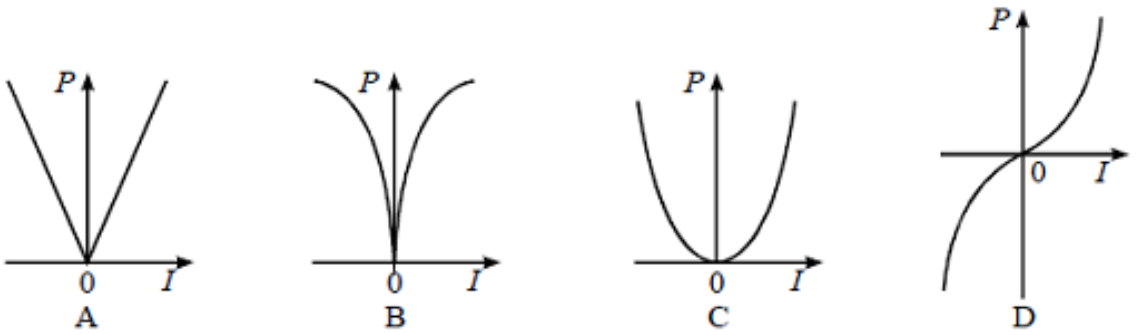
(Total 1 mark)

6.18. The diagram shows two wires, **P** and **Q**, of equal length, joined in series with a cell. A voltmeter is connected between the end of **Q** and a point **X** on the wires. The p.d. across the cell is V. Wire **Q** has twice the area of cross-section and twice the resistivity of wire **P**. The variation of the voltmeter reading as the point **X** is moved along the wires is best shown by:



(Total 1 mark)

6.19. A metal wire is maintained at a constant temperature. Which one of the following graphs best represents the relationship between the dissipated power P and the current I in the wire?



(Total 1 mark)

6.20. Two resistors R_1 and R_2 are made of wires of the same material. The wire used for R_1 has half the diameter and is twice as long as the wire used for R_2.

What is the value of the ratio $\frac{\text{resistance of } R_1}{\text{resistance of } R_2}$?

A 8

B 4

C 1

D 0.5

(Total 1 mark)

6.21. The resistance of a metallic conductor increases with temperature because, at higher temperatures,

A more electrons become available for conduction

B the conductor becomes a superconductor

C the amplitude of vibration of lattice ions increases

D the length and cross-sectional area of the conductor both increase

(Total 1 mark)

ANSWERS

SECTION 1

1.1. D
1.2. B
1.3. C
1.4. D
1.5. D
1.6. B
1.7. C
1.8. B
1.9. B
1.10. A
1.11. A
1.12. D
1.13. C
1.14. C
1.15. C

SECTION 2

2.1. D
2.2. D
2.3. A
2.4. A
2.5. A
2.6. D
2.7. C
2.8. D
2.9. A
2.10. A
2.11. C
2.12. B
2.13. B
2.14. D
2.15. B
2.16. B
2.17. C
2.18. D
2.19. B
2.20. D
2.21. D
2.22. B
2.23. C
2.24. A
2.25. B
2.26. D
2.27. A
2.28. D
2.29. C
2.30. A
2.31. C
2.32. B
2.33. C
2.34. A
2.35. B

SECTION 3

3.1. A
3.2. C
3.3. B
3.4. C
3.5. A
3.6. C
3.7. C

SECTION 4

4.1. D
4.2. C
4.3. D
4.4. C
4.5. C
4.6. B
4.7. D
4.8. C
4.9. B
4.10. A
4.11. C
4.12. C
4.13. B
4.14. D
4.15. A
4.16. D
4.17. C
4.18. A
4.19. B
4.20. D
4.21. D
4.22. C
4.23. B
4.24. A
4.25. A
4.26. D
4.27. C
4.28. B
4.29. C
4.30. B
4.31a. A
4.31b. D
4.32. C
4.33. C
4.34. A
4.35 .B
4.36. D
4.37. B
4.38. C
4.39. B
4.40. A
4.41. B
4.42. B
4.43. C

SECTION 5

5.1. C
5.2. C
5.3. C
5.4. A
5.5. C
5.6. C
5.7. C
5.8. B
5.9. A
5.10. D
5.11. C
5.12. B
5.13. B
5.14. C
5.15. B
5.16. A
5.17. B
5.18. B

SECTION 6

6.1. C

6.2. D

6.3. B

6.4. D

6.5 A

6.6. C

6.7. D

6.8. B

6.9. C

6.10. B

6.11. B

6.12. A

6.13. A

6.14. A

6.15. C

6.16. B

6.17. D

6.18. B

6.19. C

6.20. A

6.21. C