TEMASEK JUNIOR COLLEGE

2015 Preliminary Examination
Higher 1

PHYSICS

8866/01

Paper 1 Multiple Choice

17 September 2015
1 hour

Additional Materials: Multiple Choice Answer Sheet

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.
Do not use staples, paper clips, highlighters, glue or correction fluid.
Write your name, Civics group and Index Number on the Answer Sheet in the spaces provided.

There are **thirty** questions in this paper. Answer **all** questions. For each question there are four possible answers, **A**, **B, C** and **D**.
Choose the **one** you consider correct and record your choice in **soft pencil** on the separate Answer Sheet.

Read the instructions on the Answer Sheet very carefully.

Each correct answer will score one mark. A mark will not be deducted for a wrong answer.
Any rough working should be done in this booklet.

The use of an approved scientific calculator is expected, where appropriate.

This booklet consists of **14** printed pages.

[Turn over

Data

speed of light in free space,	c	=	3.00×10^{8} m s^{-1}
elementary charge,	e	=	1.60×10^{-19} C
the Planck constant,	h	=	6.63×10^{-34} J s
unified atomic mass constant,	u	=	1.66×10^{-27} kg
rest mass of electron,	m_e	=	9.11×10^{-31} kg
rest mass of proton,	m_p	=	1.67×10^{-27} kg
acceleration of free fall,	g	=	9.81 m s^{-2}

Formulae

uniformly accelerated motion,	s	=	$ut + \frac{1}{2}at^2$
	v^2	=	$u^2 + 2as$
work done on/by a gas,	W	=	$p\Delta V$
hydrostatic pressure,	p	=	ρgh
resistors in series,	R	=	$R_1 + R_2 + \ldots$
resistors in parallel,	$1/R$	=	$1/R_1 + 1/R_2 + \ldots$

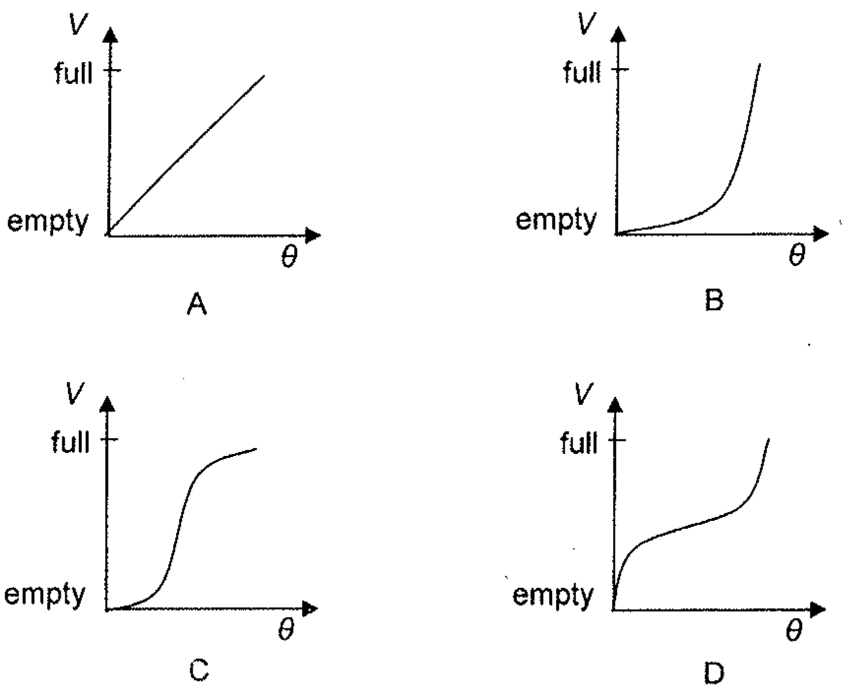
1 A flat head drill bit is used to drill holes of small depth. The drill bit can drill holes with a diameter size of (40.0 ± 0.5) mm. The depth of the hole has an uncertainty of ± 1mm.

If the total percentage uncertainty of the volume made by the hole is less than 10%, what is the minimum depth, in mm, which the drill bit can make?

A 15 **B** 14 **C** 13 **D** 12

2 A petrol gauge in a car indicates the volume V of fuel in the tank. V is given by the angular deflection θ of the pointer on a dial. Below are the calibration curves for the four different gauges.

For **high** fuel levels in the tank, which gauge would be most sensitive?



3 A ball is thrown upwards at an angle to the horizontal with an initial speed.

Assuming that air resistance is not negligible, which of the following statements is **incorrect**?

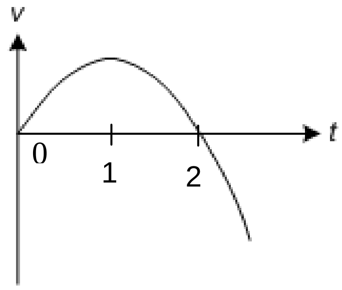
A The time taken for the flight up to the highest point is longer than the time taken for the flight down.

B The maximum height reached by the ball is smaller than that with negligible air resistance.

C The horizontal range of the ball is shorter than that with negligible air resistance.

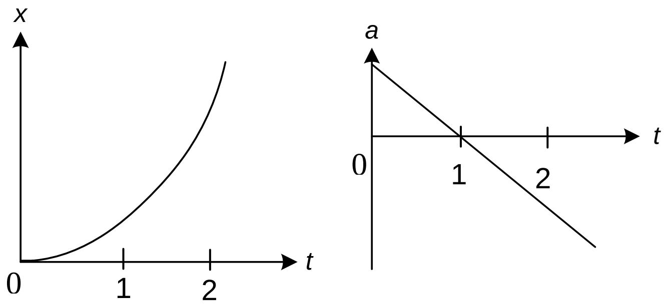
D The path of the ball is asymmetrical about the highest point.

4 The variation with time *t* of the velocity *v* of a particle is shown in the figure below.

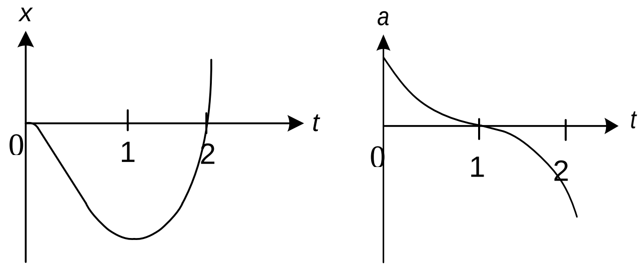


Which of the following pairs of graphs best represents the variation with time of the displacement, *x,* and acceleration, *a,* for the particle?

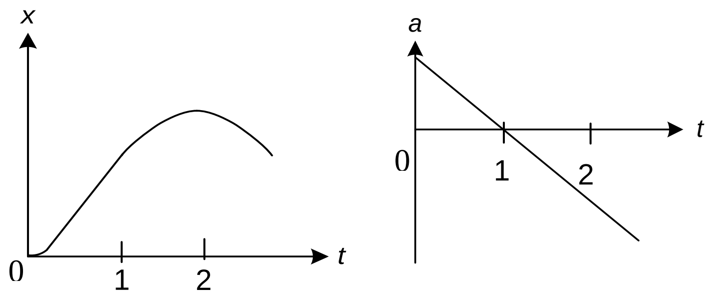
A



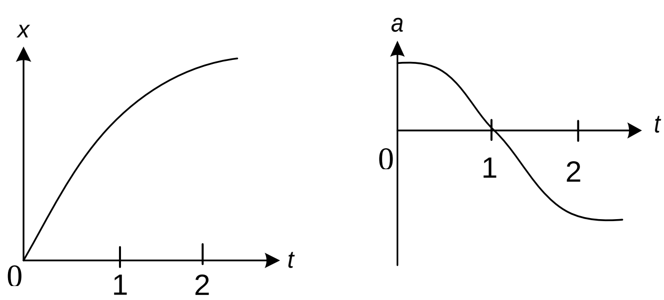
B



C



D

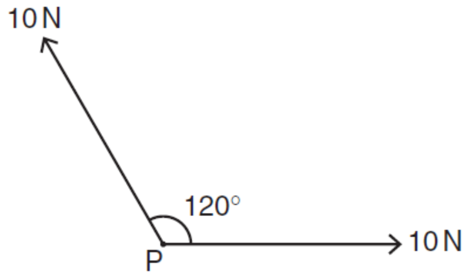


5 A car is travelling at a speed of 15 m s^{-1} and can be brought to rest with a uniform deceleration in 1.2 s if the brakes are applied. The reaction time of the driver is 0.10 s.

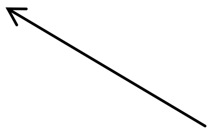
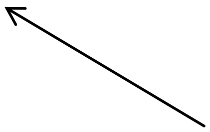
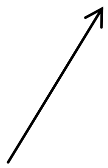
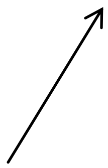
What is the closest distance that the moving car can be to a stationary object if a collision is to be avoided?

A 9.00 m **B** 10.5 m **C** 12.0 m **D** 19.5 m

6 Two forces, each of 10 N, act at a point P as shown in the diagram. The angle between the directions of the forces is 120°.



What is the magnitude and direction of the resultant force?

	magnitude / N	direction
A	5	
B	10	
C	10	
D	20	

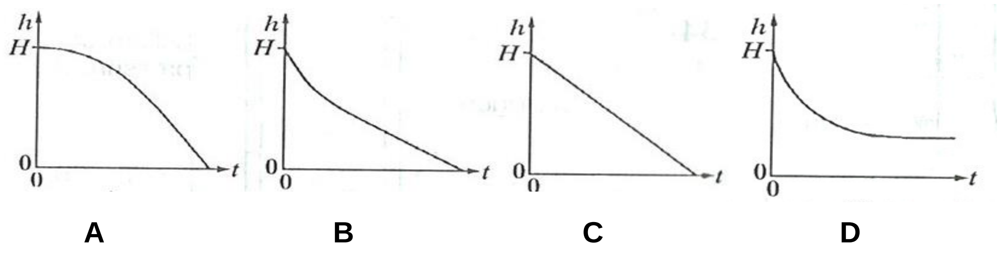
7 An object of mass 0.30 kg is dropped from a height of 1.2 m. On impact with the ground, the object comes to rest in 0.40 s.

What is the contact force on the object?

A 0.66 N **B** 3.6 N **C** 4.4 N **D** 6.6 N

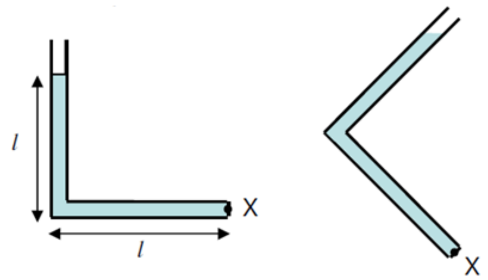
8 A steel ball-bearing is released at the surface of a viscous liquid contained in a tall, wide jar. In falling through the liquid, the ball-bearing experiences a retarding force proportional to the velocity.

If the depth of the liquid in the jar is H, which one of the following graphs best represents the variation of the height h of the ball-bearing above the base with time t?



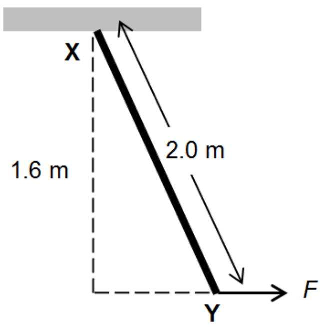
9 A long and thin L-shaped tube is filled with liquid to the depth as shown in the figure below. The pressure at X due to the liquid alone is P. The tube is then rotated by an angle of 45°.

What is the new pressure exerted at X due to the liquid?



A ½ P **B** P **C** $\sqrt{2}$ P **D** 2 P

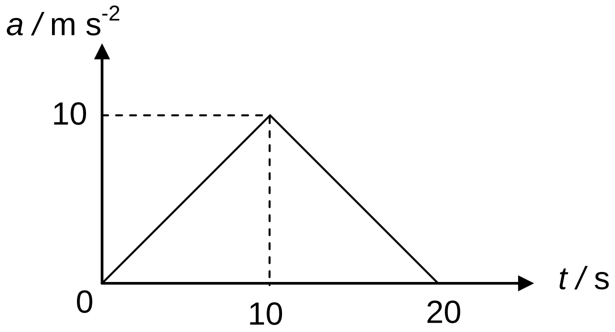
10 The figure below shows a heavy uniform rod XY of length 2.0 m and weight 400 N. It is hinged at X and held to one side by a horizontal force F acting at Y.



What is the magnitude of F?

A 150 N **B** 200 N **C** 250 N **D** 300 N

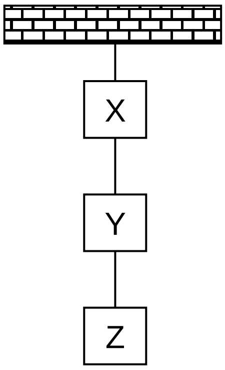
11 An object of mass 5.0 kg has an acceleration that varies with time as shown below.



What is the change in its momentum after 20 s?

A 100 N s **B** 200 N s **C** 400 N s **D** 500 N s

12 Three blocks X, Y and Z each of mass 1.0 kg, are suspended from a ceiling by pieces of light elastic string as shown.



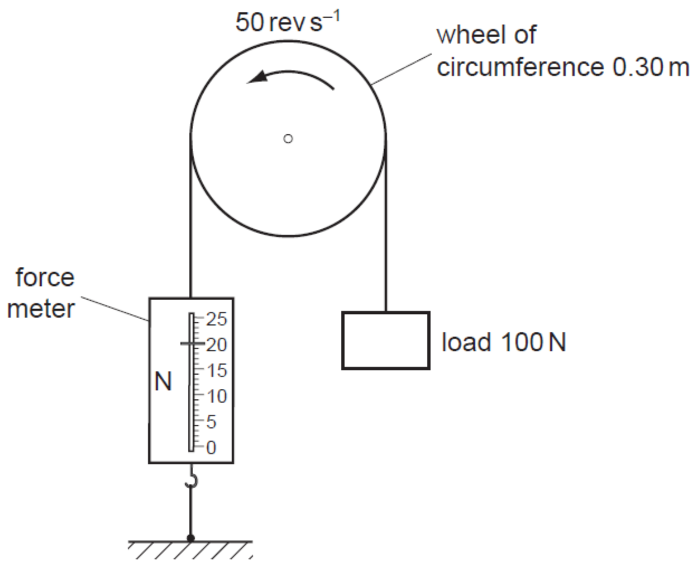
The arrangement is allowed to come into static equilibrium and then the string connecting X and Y is cut.

At this instant, what is the upward acceleration of X? (Take g as 10 m s^{-2})

A 0 m s^{-2} **B** 10 m s^{-2} **C** 20 m s^{-2} **D** 30 m s^{-2}

13 The diagram shows a wheel of circumference 0.30 m. A rope is fastened at one end to a force meter. The rope passes over the wheel and supports a freely hanging load of 100 N. The wheel is driven by an electric motor at a constant rate of 50 revolutions per second.

When the wheel is turning at this rate, the force meter reads 20 N.



What is the output power of the motor?

A 0.3 kW **B** 1.2 kW **C** 1.8 kW **D** 3.8 kW

14 A wind turbine has blades that sweep an area of 2000 m^2. It converts the power available in the wind to electrical power with an efficiency of 50%.

What is the electrical power generated if the wind speed is 10 m s^{-1}? (The density of air is 1.3 kg m^{-3}.)

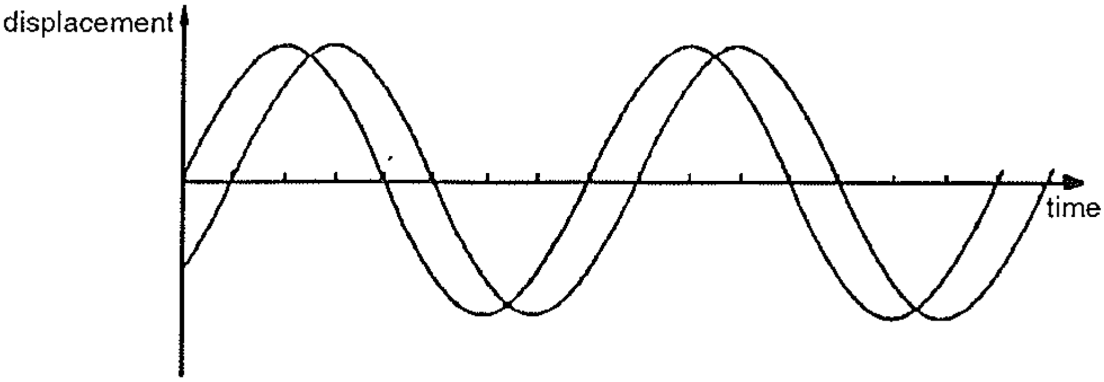
A 130 kW **B** 650 kW **C** 1300 kW **D** 2600 kW

15 A 200 g block is pressed against a spring of force constant 1.4 N mm^{-1} with a compression of 10.0 cm. The compressed spring and block are at rest at the bottom of a ramp inclined at 60° to the horizontal. A constant frictional force of 1.2 N exists between the block and the ramp.

The spring is released. How far up the incline will the block move before it comes to rest?

A 2.41 m **B** 3.21 m **C** 4.12 m **D** 7.14 m

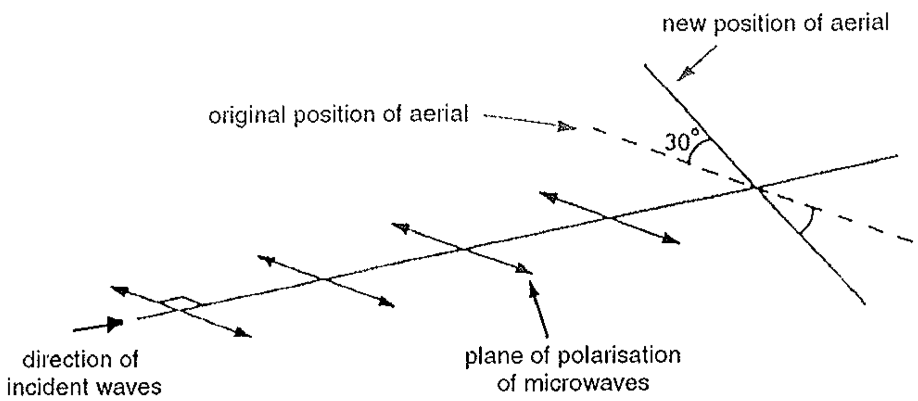
16 The diagram below shows the variation with time of the displacement for two oscillations.



What is the phase difference between the oscillations?

A $\pi/4$ **B** $\pi/2$ **C** $3\pi/4$ **D** $3\pi/2$

17 A beam of plane-polarised microwaves is incident upon an aerial which is initially positioned to give maximum response. In a storm, the aerial is rotated about the direction of the incident waves until it makes an angle of 30° to the plane of polarisation, as shown in the figure below.



What is the percentage reduction in the intensity of the signal now received from the aerial?

A 13 % **B** 25 % **C** 50 % **D** 75 %

18 Ripples on the surface of a pond spread out in circles from the point of an initial disturbance.

Assume that the energy of the wave is spread over the entire circumference of the ripple. The amplitude *A* at a distance *r* from the initial disturbance is proportional to

A $\frac{1}{\sqrt{r}}$ **B** $\frac{1}{r}$ **C** $\frac{1}{r^2}$ **D** $\sqrt{r}$

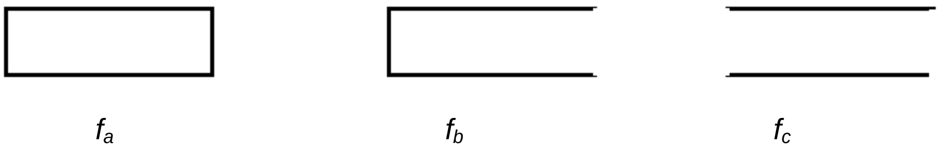
19 A sound wave of frequency 1500 Hz propagates from left to right through a gas. The diagram below shows the positions of some gas molecules at a particular instant of time.

The distance between particles P and Q is 0.500 m.

What is the speed of sound in this gas?

A 300 m s^{-1} **B** 330 m s^{-1} **C** 375 m s^{-1} **D** 400 m s^{-1}

20 Air filled pipes of equal length are represented in figure below.

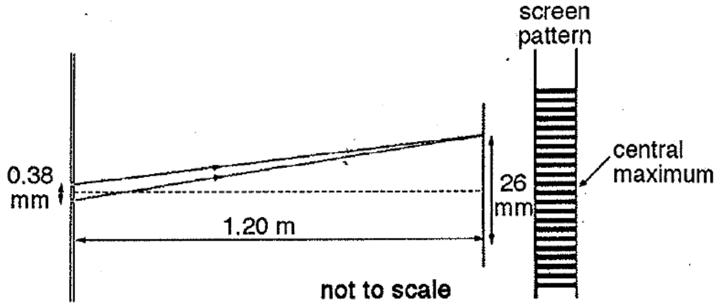


f_a , f_b and f_c are the frequencies of the fundamental vibrations of the pipes.

What is the ratio $f_a : f_b : f_c$?

A 1 : 2 : 1 **B** 1 : 2 : 3 **C** 2 : 1 : 2 **D** 3 : 2 : 1

21 Coherent, monochromatic light from two narrow slits a distance 0.38 mm apart causes an interference pattern on a screen 1.20 m from the slits as shown in the diagram.

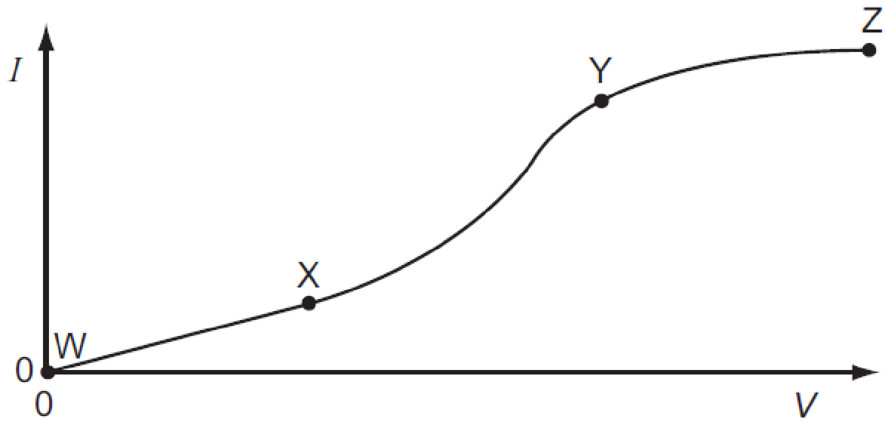


The distance from the sixth bright fringe on one side of the pattern to the sixth bright fringe on the other side of the pattern is found to be 26 mm.

What is the wavelength of the monochromatic light?

A 633 nm **B** 686 nm **C** 748 nm **D** 760 nm

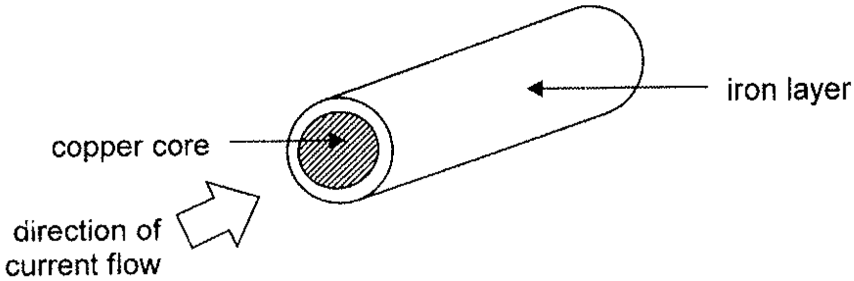
22 An electrical component has a potential difference V across it and a current I through it. A graph of I against V is drawn and is marked in three sections WX, XY and YZ.



How does the resistance of the component vary within each of the three sections, as V increases?

	WX	XY	YZ
A	constant	decreases	increases
B	constant	increases	decreases
C	increases	decreases	increases
D	increases	increases	decreases

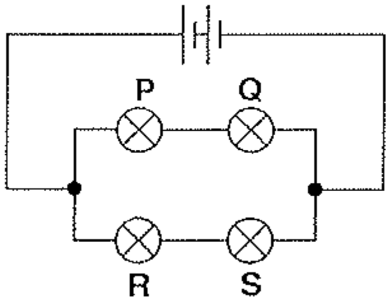
23 The diagram below shows a resistor made of a copper cylindrical core of cross-sectional area 2.0×10^{-3} m^2 which is surrounded by iron of cross-sectional area 1.0×10^{-3} m^2.



Given that copper and iron have resistivities of 1.7×10^{-8} Ω m and 1.0×10^{-7} Ω m respectively, what is the resistance per unit length of such a resistor?

A 7.8×10^{-6} Ω m^{-1}
B 8.5×10^{-6} Ω m^{-1}
C 1.5×10^{-5} Ω m^{-1}
D 3.9×10^{-5} Ω m^{-1}

24 When four identical lamps P, Q R and S are connected as shown in diagram 1, they have normal brightness.



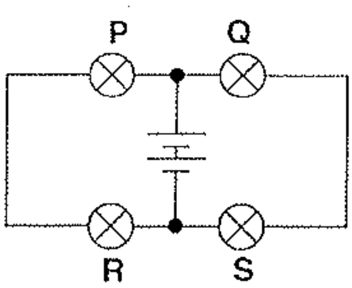
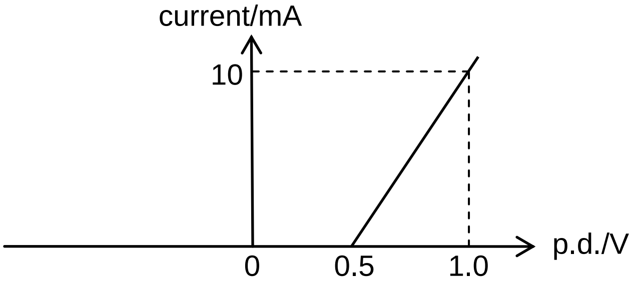


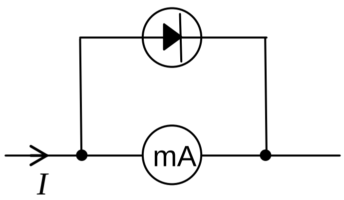
Diagram 1 Diagram 2

When the four lamps are connected as shown in diagram 2, which statement is **correct**?

A The lamps do not light.
B The lamps are less bright than normal.
C The lamps have normal brightness.
D The lamps are brighter than normal.

25 The current that passes through a certain diode varies with the potential difference across it as shown in the graph below.



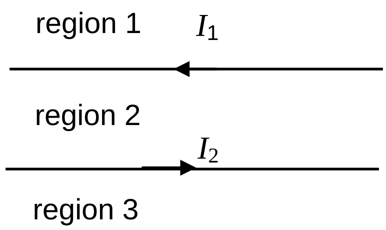


The diode is connected in parallel with a milliammeter of resistance 100 Ω as shown in the circuit above.

What is the value of the direct current I when the current through the milliammeter is 8 mA?

A 8 mA **B** 14 mA **C** 16 mA **D** 20 mA

26 Two long straight and parallel wires carrying currents in opposite directions separate the surrounding space into three regions 1, 2 and 3.



In which region(s) can there be a neutral point (that is, a point of zero magnetic field)?

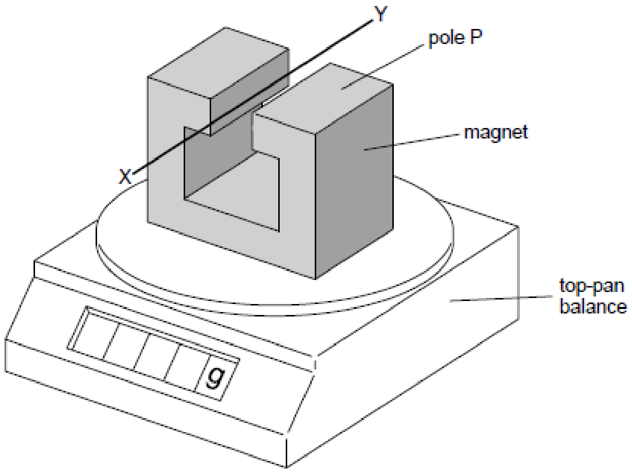
A Region 2 only.

B Either region 1 or region 3 but not both.

C Both regions 1 and 3.

D There are no neutral points.

27 A large horseshoe magnet produces a uniform magnetic field of flux density *B* between its poles. Outside the region of the poles, the flux density is zero. The magnet is placed on a top-pan balance and a stiff wire XY is situated between its poles, as shown in the figure below.



The wire XY is horizontal and normal to the magnetic field. The length of wire between the poles is 4.4 cm. A direct current of magnitude 2.6 A is passed through the wire in the direction from X to Y. The reading on the top-pan balance increases by 2.3 g.

What is the polarity of pole P of the magnet and the magnitude of the flux density between the poles?

	polarity of P	flux density / T
A	north	0.020
B	north	0.20
C	south	0.20
D	south	200

28 In a photoelectric experiment, a parallel beam of monochromatic light is incident on a cathode having a work function of 2.06 eV. When a graph of photocurrent against voltage is plotted, the stopping potential obtained is 0.70 V.

What is the momentum of a photon from this light source?

A 9.20×10^{-28} Ns **B** 1.06×10^{-27} Ns **C** 1.33×10^{-27} Ns **D** 1.47×10^{-27} Ns

29 A beacon emits flashes of green light of frequency 6.20×10^{14} Hz uniformly in all directions at 1 second intervals. The light power during each flash is 10 W. An observer has a telescope with an aperture of area 2.00×10^{-3} m^2. His eye-brain system perceives a flash of light when 50 or more photons are incident on a small area of his retina in less than 0.10 s.

What is the approximate maximum range at which the beacon might be detected by the observer using the telescope?

A 2.78×10^{6} m **B** 4.82×10^{6} m **C** 5.56×10^{6} m **D** 2.85×10^{4} m

30 Which of the following statements explains the existence of energy levels within atoms?

A Atoms in a solid can diffract electrons in the same way as crystals diffract X-rays.

B Photoelectrons are only emitted from a metal surface for incident photos of wavelengths shorter than a critical wavelength.

C When viewed through a diffraction grating, line spectra can be observed from a sodium vapour lamp.

D Electrons emitted from the surface of a metal have a maximum kinetic energy dependent on the frequency of the incident light.

2015 Prelims H1 Paper 1 Worked Solutions

1 B	2 C	3 A	4 C	5 B	6 C	7 D	8 A	9 C	10 A
11 D	12 C	13 B	14 B	15 A	16 A	17 B	18 A	19 C	20 C
21 B	22 A	23 A	24 C	25 B	26 B	27 B	28 D	29 A	30 C

1 **B**

$$V = \frac{\pi D^2 h}{4}$$
$$\frac{\Delta V}{V} = \frac{2\Delta D}{D} + \frac{\Delta h}{h}$$
$$\Rightarrow \frac{2 \times 0.5}{40.0} + \frac{1}{h} < 0.1$$
$$\Rightarrow h > 13.3 \text{ mm}$$

2 **C** large change in θ for small change in V

3 **A** The time taken for the flight up to the highest point should be shorter than the time taken for the flight down.

4 **C** gradient of x-t gives v-t graph and gradient of v-t graph gives a-t graph.

5 **B** v = u + a t
0 = 15 + a (1.2)
a = -12.5 m s^{-2}

$v^2 = u^2 + 2 a s_B$
$0 = 15^2 + 2 (-12.5) s_B$
s_B = 9.0 m

Total distance = thinking distance + braking distance
= 15 x 0.10 + 9.0
= 10.5 m

6 **C** Resolve the vectors into vertical and horizontal components (or draw vector triangle)
Net Vertical Force: 10 cos 30° = 8.7 N
Net Horizontal Force: 10 – 10 sin 30° = 5 N
$$F_{net} = \sqrt{8.7^2 + 5^2} = 10 \text{ N}$$

7 **D** Find speed just before impact: $v^2 = u^2 + 2as$
$$v = \sqrt{0^2 + 2 \times 9.81 \times 1.2}$$
= 4.85 m s^{-1}

$$\text{Net force} = \frac{\Delta p}{\Delta t}$$
$$N - 0.30x9.81 = \frac{(0.30 \times 4.85) - 0}{0.40}$$
N = 6.6 N

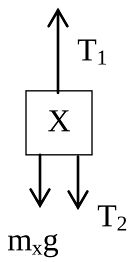
8 **A** Initially the ball-bearing falls with gravitational acceleration. As the speed increases, the retarding force increases until terminal speed is reached when it falls with constant speed. So h decreases with progressively increasing rate and then a constant rate with time.

9 **C** $p = \rho g h \propto h$
When rotated by an angle of 45°, the height and hence the pressure is increased by a factor of $\sqrt{2}$.

10 **A** By Pythagoras theorem, the horizontal component of length of the rod is 1.2 m
Take moment about X,
$F(1.6) = 400(0.6)$
$F = 150\text{ N}$

11 **D** Area under a-t graph = Δv
½ (10)(20) = 100 = Δv
$\therefore \Delta p = m\Delta v = 5.0\ (100) = 500$ N s

12 **C** When string between X and Y is cut, net force on X is now equal to T_2`in magnitude (but acting upwards).



$F_{net} = m_x a$
$(m_y+m_z)g = m_x a$
(1.0+1.0)(10) 1.0a
$a = 20\text{ m s}^{-2}$

13 **B** Motor exerts a force of 80 N on rope.

$$P = Fv = 80 \times \frac{circumference}{T} = 80 \times 0.30 \times 50 = 1200\text{ W}$$

14 **B**

$$\text{power available from wind} = \frac{E}{t} = \frac{\frac{1}{2}mv^2}{t} = \frac{1}{2}\rho A v^3 = \frac{1}{2}(1.3)(2000)(10)^3 = 1.3x10^6\text{ W}$$

$$\text{power converted usefully} = 0.50\text{ x }1.3x10^6 = 650\ 000\text{ W}$$

15 **A** Loss in EPE = Gain in GPE + W.D against friction

$$\frac{1}{2}kx^2 = mgd\sin\theta + fd$$

$$\frac{1}{2}(1400)(0.10)^2 = (0.200)(9.81)d\sin 60^\circ + 1.2d$$

$$d = 2.41\text{ m}$$

16 **A** $\frac{t}{T} = \frac{\phi}{2\pi}$

$\frac{1}{8} = \frac{\phi}{2\pi} \Rightarrow \phi = \frac{\pi}{4}$

17 **B** Transmitted Amplitude = A cos 30°

$I \propto A^2$

$\frac{I'}{I} = \left(\frac{A'}{A}\right)^2 = \left(\frac{A\cos 30°}{A}\right)^2 = 0.75$

$I' = 0.75I$

$\frac{\Delta I}{I} x100\% = \frac{I - 0.75I}{I} x100\% = 25\%$

18 **A** $I = \frac{E}{t(2\pi r)} \propto A^2$

$\therefore A^2 \propto \frac{1}{r} \Rightarrow A \propto \frac{1}{\sqrt{r}}$

19 **C** Between PQ of distance = 0.500 m, there are 2 wavelengths.
v = f λ= 1500 (0.500/2) = 375 m s^{-1}

20 **C** For air filled pipes, the closed end must be a node and the open end must be an antinode.
=> λ = 2L, 4L and 2L for the 3 pipes respectively
=> ratio of λ is 1:2:1
$f = \frac{v}{\lambda} \propto \frac{1}{\lambda}$ and hence ratio of f is 2:1:2

21 **B** $\Delta x = \frac{\lambda D}{a} \Rightarrow \frac{26 \times 10^{-3}}{12} = \frac{\lambda(1.20)}{0.38 \times 10^{-3}} \Rightarrow \lambda = 686$ nm

22 **A** R is the ratio of V to I. This ratio is related to the inverse of the gradient of a straight line drawn through the origin.

23 **A** $1/R = 1/R_{copper} + 1/R_{iron}$
$= 1/(\rho_{copper}\, l / A_{copper}) + 1/(\rho_{iron}\, l / A_{iron})$
$R/l = (A_{copper}/\rho_{copper} + A_{iron}/\rho_{iron})^{-1} = 7.8 \times 10^{-6}\ \Omega\ m^{-1}$

24 **C** Both circuits are identical.

25 **B** p.d. across milliammeter = $8 \times 10^{-3} \times 100 = 0.8$ V
From graph, current through diode in forward direction = 6 mA
Hence total current I = 8 + 6 = 14 mA

26 **B** Use right hand grip rule. One of the currents must be smaller than the other.

27 **B** force on magnet / balance is downwards => by Newton's third law force on wire is upwards => pole P is a north pole
$F = BIL = mg$
$B \times 2.6 \times 4.4 \times 10^{-2} = 2.3 \times 10^{-3} \times 9.81$
$B = 0.20$ T

28 **D** $\frac{hc}{\lambda} = eV_s + \varphi$, $p = \frac{h}{\lambda}$

$pc = (0.70 + 2.06) \times 1.6 \times 10^{-19}$

$p = 1.47 \times 10^{-27}$ N s

29 **A** $P = \frac{n}{t}hf$

$10 = \frac{n}{t}\left(6.63 \times 10^{-34} \times 6.20 \times 10^{14}\right)$

$\frac{n}{t} = 2.43 \times 10^{19}$

$\frac{2.00 \times 10^{-3}}{4\pi r^2} = \frac{50/0.10}{2.43 \times 10^{19}}$

$r = 2.78 \times 10^{6}$ m

30 **C**