JURONG JUNIOR COLLEGE
JC2 Preliminary Examination 2017

Name		Class	17S

PHYSICS **8866/01**

Higher 1

Multiple Choice **15 Sep 2017**

1 hour

Additional Materials: Multiple Choice Answer Sheet
Soft clean eraser
Soft pencil (type B or HB is recommended)

READ THESE INSTRUCTIONS FIRST

Do not open this booklet until you are told to do so.

Write your **name** and **class** in the spaces provided at the top of this page.

Write in soft pencil.
Do not use staples, paper clips, highlighters, glue or correction fluid.
Write your name, class and index number on the Answer Sheet in the spaces provided.

There are **thirty** questions on 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.

(This question paper consists of 16 printed pages)

Data

speed of light in free space,	c	$= 3.00 \times 10^{8}$ m s^{-1}
elementary charge,	e	$= 1.60 \times 10^{-19}$ C
the Planck constant,	h	$= 6.63 \times 10^{-34}$ J s
unified atomic mass constant,	u	$= 1.66 \times 10^{-27}$ kg
rest mass of electron,	m_e	$= 9.11 \times 10^{-31}$ kg
rest mass of proton,	m_p	$= 1.67 \times 10^{-27}$ 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	$= \rho gh$
resistors in series,	R	$= R_1 + R_2 + \ldots$
resistors in parallel,	$1/R$	$= 1/R_1 + 1/R_2 + \ldots$

1 What is a realistic estimate of the magnitude of the average momentum of an Olympic 100 m sprinter?

A 10 N s

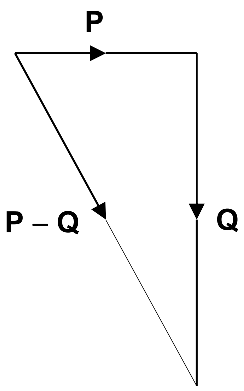
B 70 N s

C 700 N s

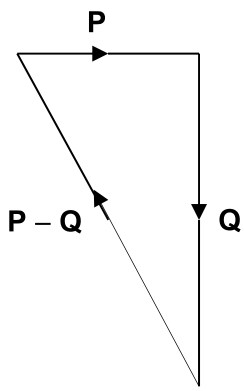
D 3000 N s

2 Which vector triangle shows the resultant of the vector subtraction **P** – **Q**?

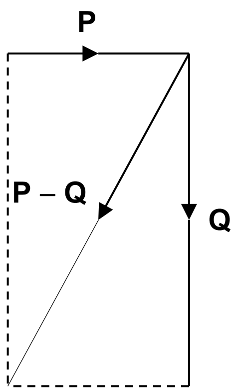
A



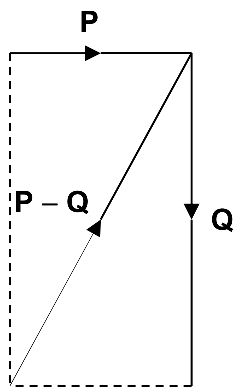
B



C

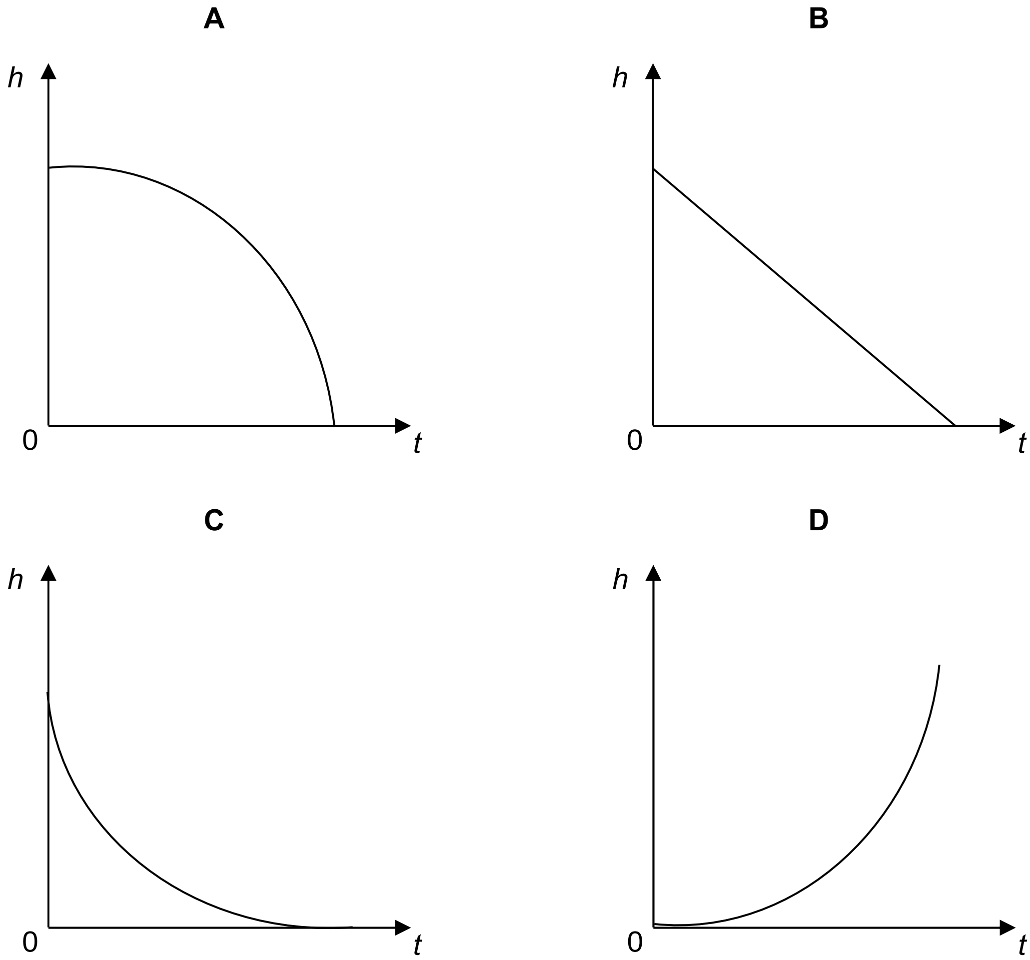


D



3 A small steel ball falls towards the ground after being released from rest.

Which graph best represents the variation with time t of the height h of the ball measured from the ground?



4 A crew of an oil tanker spotted an iceberg in its path and immediately sounded the alarm. At the time when the engine of the oil tanker was driven to slow it down, the oil tanker was moving at 10 m s^{-1}, the iceberg was 800 m away and moving at 0.5 m s^{-1} in the same direction as the oil tanker. The oil tanker managed to stop just 20 m from the iceberg.

Determine the average deceleration of the oil tanker.

A 0.055 m s^{-2}

B 0.058 m s^{-2}

C 0.067 m s^{-2}

D 0.071 m s^{-2}

5 A golfer hits a golf ball on a flat golf course. The golf ball reaches a maximum height of 23 m.

Determine the time of flight of the golf ball.

A 2.2 s

B 4.3 s

C 4.7 s

D 9.4 s

6 A 4.0 kg food parcel attached to a parachute descends at a constant velocity of 2.0 m s^{-1}. You may take the acceleration of free fall as 10 m s^{-2}.

What is the resultant force acting on the parcel?

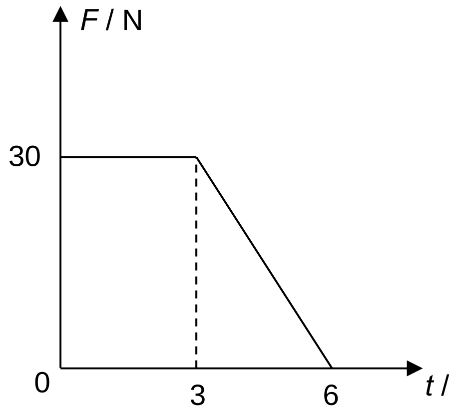
A 0 N

B 8 N

C 20 N

D 40 N

7 An object of mass 20 kg moves along a straight line on a smooth horizontal surface. A force F acts on the object in its direction of motion. The variation with time t of force F is shown below.



What is the velocity of the object at t = 6 s if its velocity at t = 4 s is 4.5 m s^{-1}?

A 3.5 m s^{-1}

B 5.5 m s^{-1}

C 6.8 m s^{-1}

D 11 m s^{-1}

8 Rubber bullets, each of mass m, are fired at the rate of n bullets per second on a vertical wall. The speed of each bullet is u and they rebound from the wall with the same speed.

Determine the average force exerted on the wall.

A mnu

B $2mnu$

C $mnug$

D $2mnug$

9 An object of mass *m* is hanging on a string from the roof of a lift. The lift is moving upwards, but slowing down.

The tension in the string is

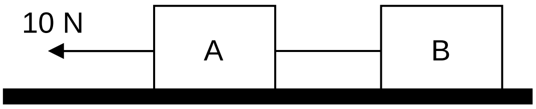
A zero.

B less than *mg*.

C equal to *mg*.

D more than *mg*.

10 Blocks A and B have the same mass but different roughness. When block A is pulled with a force of 10 N, blocks A and B experience frictional forces of 4 N and 2 N respectively.



What is the tension in the rope joining blocks A and B?

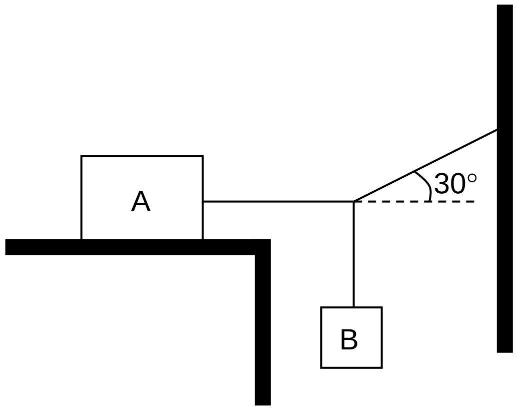
A 2 N

B 4 N

C 6 N

D 8 N

11 Inextensible strings hold blocks A and B in equilibrium as shown in the diagram. The friction between block A and the rough horizontal surface is 1.8 N.



Determine the weight of block B.

A 0.90 N

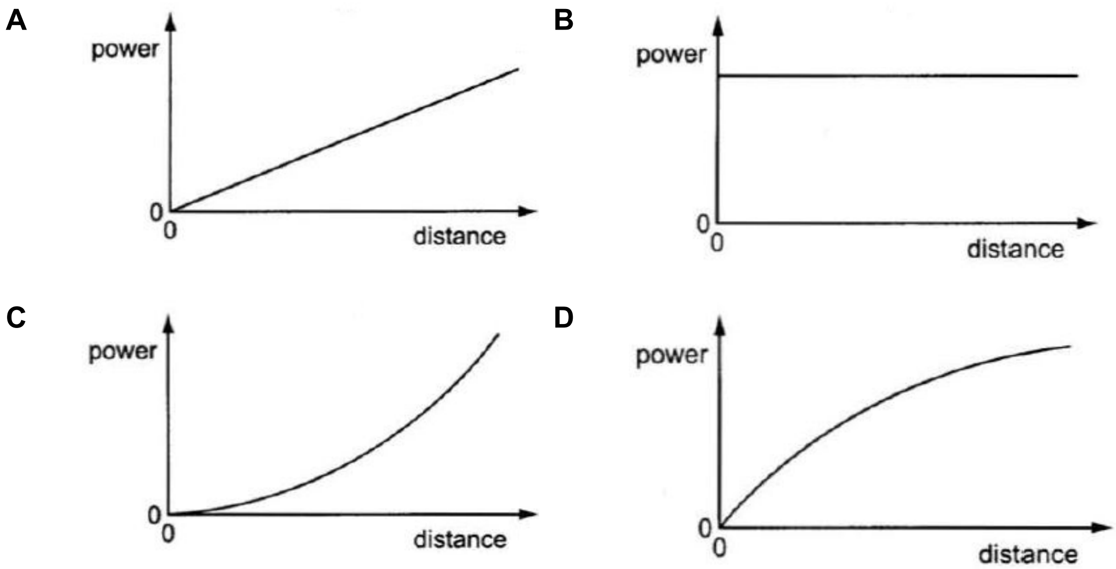
B 1.0 N

C 1.6 N

D 3.1 N

12 A vehicle starts from rest and accelerates uniformly.

Which graph shows how the power output of the vehicle varies with distance travelled?



13 A small metal sphere of mass *m* moves through a viscous liquid.

When it reaches a constant downward velocity *v*, which of the following describes the changes with time in the kinetic energy and gravitational potential energy of the sphere?

	change in kinetic energy	gravitational potential energy
A	$\frac{1}{2}mv^2$	decreases at a rate of mgv
B	$\frac{1}{2}mv^2$	decreases at a rate of $(mgv - \frac{1}{2}mv^2)$
C	zero	decreases at a rate of $(\frac{1}{2}mv^2 - mgv)$
D	zero	decreases at a rate of mgv

14 Which does not involve work being done by a force?

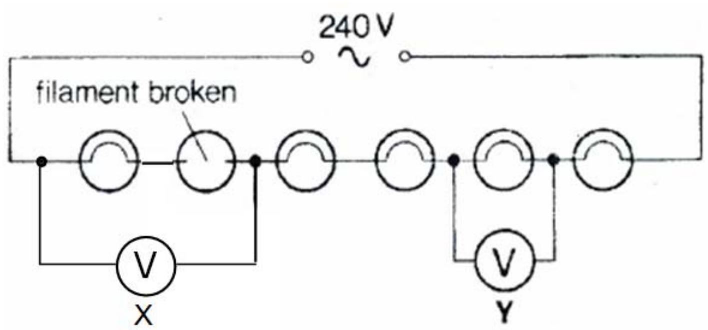
A the release of compressed air from a cylinder into the atmosphere

B the charging of a car battery

C the motion of a spacecraft in deep space

D a bicycle free-wheeling downhill at constant speed

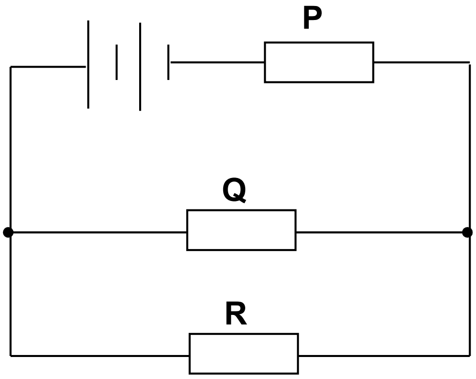
15 A mains circuit contains six similar bulbs connected in series. One of the bulbs has a broken filament. Voltmeters X and Y of infinite resistance are placed in the circuit shown below.



Which of the following voltmeter readings is correct?

	X	Y
A	0 V	0 V
B	0 V	240 V
C	240 V	240 V
D	240 V	0 V

16 The resistors **P**, **Q** and **R** in the circuit shown below have equal resistance.



The battery, of negligible internal resistance, supplies a total power of 12 W.

What is the power dissipated in resistor **R**?

A 2.0 W **B** 3.0 W **C** 4.0 W **D** 6.0 W

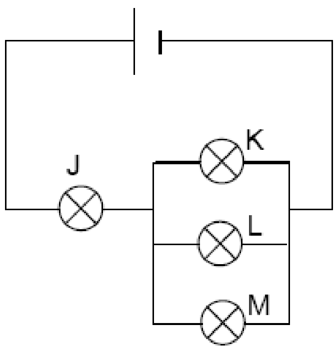
17 In an electrostatic machine, a belt of width w, having surface charge density ρ, travels with velocity v. As the belt passes a certain point, all the charge is removed and is carried away as an electric current.

What is the magnitude of this current?

A ρwv **B** ρwv^2 **C** $\dfrac{\rho w}{v}$ **D** $\dfrac{\rho v}{w}$

18 The diagram below shows four identical lamps J, K, L and M which are all lit.

Lamp K is then removed from the circuit.



Which of the following statements is correct?

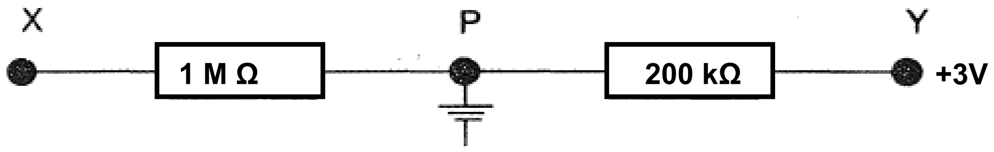
A J, L and M are equally bright.

B J is brighter than before but not as bright as L and M.

C J is less bright than before and not as bright as L and M.

D J is less bright than before but brighter than L and M.

19 Two electrical conductors, of 1 MΩ and 200 kΩ respectively, form a potential divider. Junction Y is maintained at +3 V and junction P is earthed as shown.

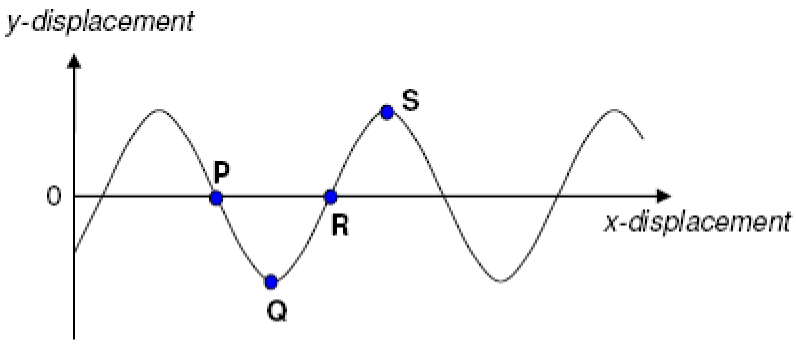


What is the potential at the other junction X?

A +15 V **B** +12 V **C** -12 V **D** -15 V

20 The graph below shows the profile of a progressive transverse wave at a particular instant of time. The waveform progress from left to right.

The particles **P**, **Q**, **R** and **S** all oscillate with uniform amplitude.



Which one of the following statements is correct?

A Particles P and R have zero kinetic energy.

B Particle P will move to the right after a while.

C Particles P and R are in anti-phase to each other.

D Particle S has the highest total energy.

21 A warning siren on top of a tall pole is taken to be a point source and radiates sound waves uniformly in all directions. At a distance 4*d*, the amplitude of the wave is *A*.

What is the distance from the siren at the point where the amplitude of the wave is 2*A*?

A 8*d* **B** 4*d* **C** 2*d* **D** *d*

22 A stationary sound wave has a series of nodes. The distance between the first and fourth node is 15.0 cm.

What is the wavelength of the sound wave?

A 4.0 cm

B 5.0 cm

C 10.0 cm

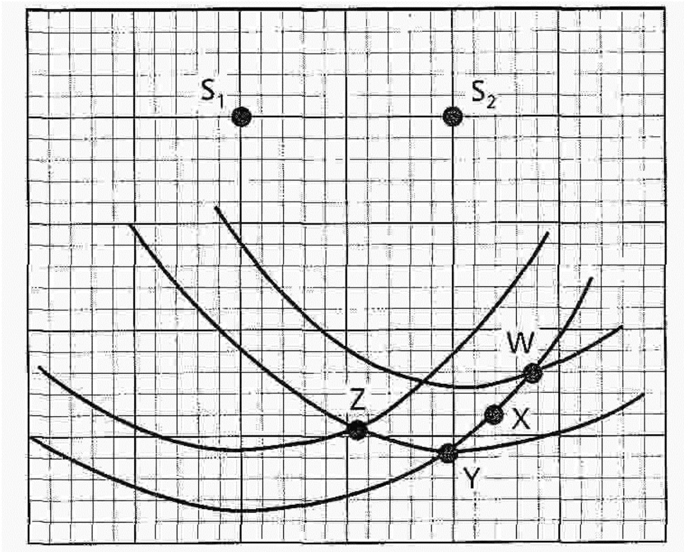
D 13.3 cm

23 A stationary sound wave was set up in a closed pipe, one end closed, but the other end open.

Which of the following row correctly describes the physical changes for the displacements of the air particles and the air pressure at the open and closed end of the pipe?

	Open end	**Closed end**
A	Displacement antinode, Pressure node	Displacement node, Pressure antinode
B	Displacement node, Pressure antinode	Displacement antinode, Pressure node
C	Displacement antinode, Pressure antinode	Displacement node, Pressure node
D	Displacement node, Pressure node	Displacement antinode, Pressure antinode

24 S_1 and S_2 are two identical sources of waves that are in phase. The instantaneous positions of two wave crests from each source are shown below.



Which of the following is true?

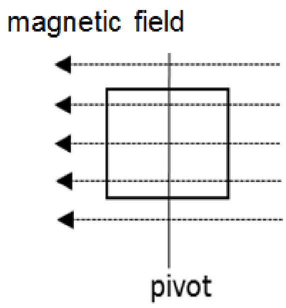
A X is a point of constructive interference.

B W is a point of destructive interference.

C $S_1Y - S_2Y = n\lambda$ where n is an integer.

D $S_1Z - S_2Z = (2n - 1)\dfrac{\lambda}{2}$ where n is an integer.

25 A 20-turns square coil of side 8.0 mm is pivoted at its centre and placed in a magnetic field of flux density 0.010 T. The two sides of the coil are parallel to the field and two sides of the coil are perpendicular to the field as shown below. A current of 5.0 mA is passed through the coil.



What is the magnitude of the torque acting on the square coil?

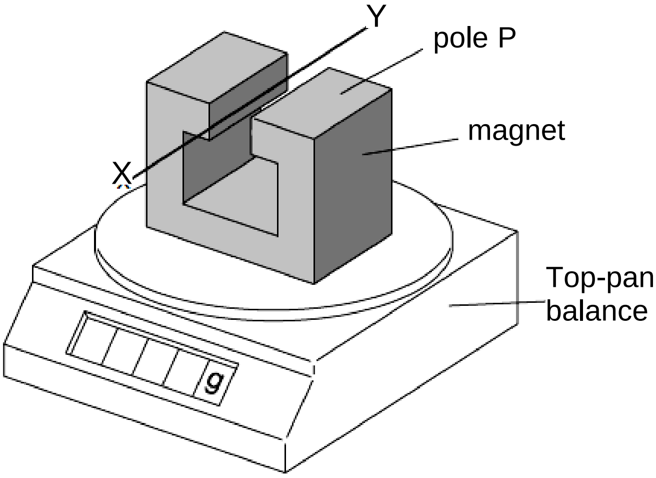
A 1.6×10^{-9} N m

B 3.2×10^{-8} N m

C 6.4×10^{-8} N m

D 3.2×10^{-5} N m

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

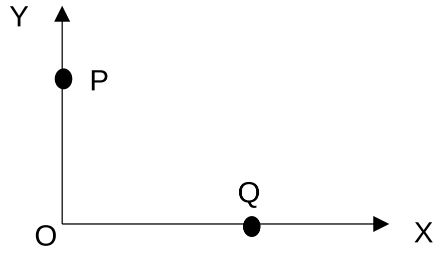


The wire XY is placed perpendicular to the magnetic field. The length of wire between the poles is 4.4 cm. A direct current of magnitude 2.6 A is passed through the wire in the direction from X to Y. The reading on the top-pan balance increases by 2.3 g.

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

27 The diagram shows a flat surface with lines OX and OY at right angles to each other.
``



Which current in a straight conductor will produce a magnetic field at O in the direction of OY?

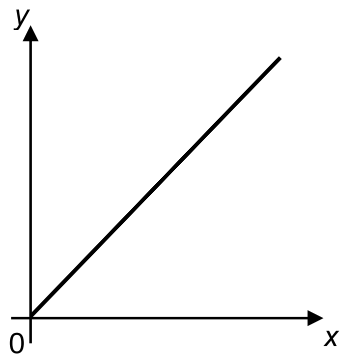
A at P into the plane of the diagram

B at P out of the plane of the diagram

C at Q out of the plane of the diagram

D at Q into the plane of the diagram

28 In a photoelectric emission experiment on a certain metal surface, two quantities, when plotted as a graph of *y* against *x*, give a straight line passing through the origin.



Which of the following correctly identifies *x* and *y* with the photoelectric quantities?

	x	*y*
A	photocurrent	threshold frequency
B	light intensity	maximum kinetic energy of photoelectrons
C	light intensity	photocurrent
D	frequency of incident light	maximum kinetic energy of photoelectrons

29 If the de Broglie waves associated with each of the following particles are to have the same wavelength, which particle must have the smallest velocity?

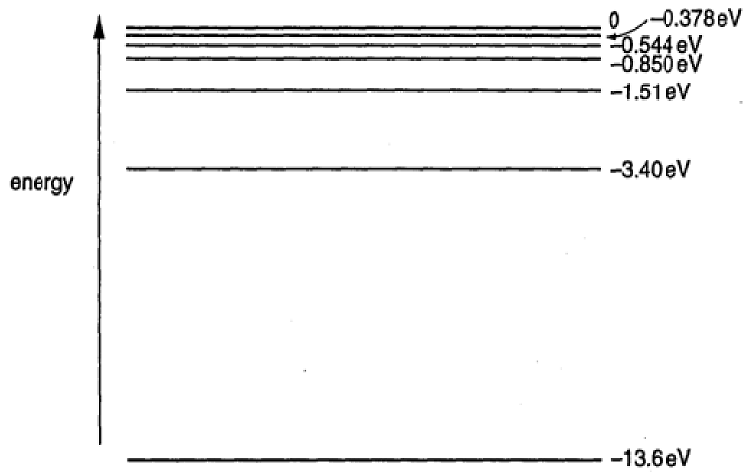
A proton

B electron

C neutron

D alpha particle (helium nucleus containing 2 neutrons and 2 protons)

30 Some of the energy levels in atomic hydrogen are shown in the figure below.



Electrons having kinetic energy of 13.00 eV are incident on a sample of cold hydrogen gas.

Assume that the photon energies corresponding to wavelengths within the visible light spectrum are between 1.78 eV and 3.11 eV.

What is the maximum number of visible spectral lines that can be observed from the emission spectrum of the gas?

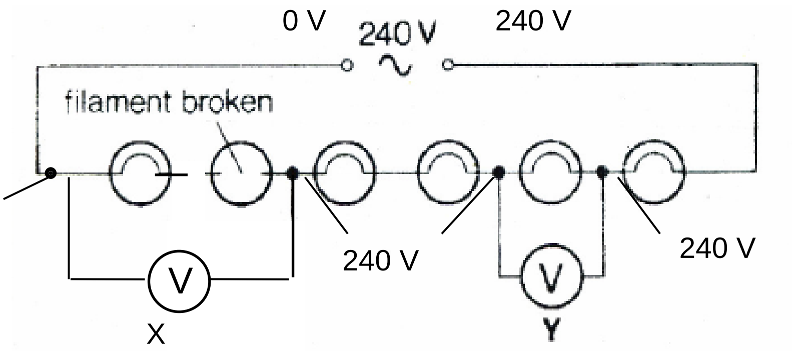
A zero **B** 2 **C** 3 **D** 6

End of paper

JURONG JUNIOR COLLEGE
PHYSICS DEPARTMENT
2017 JC2 Preliminary Examination
8866 H1 Physics Paper 1 Solutions

Qn	Ans	Suggested solution
1	**C**	The speed of Olympic sprinter is estimated to be 10 m s^{-1}. The mass of Olympic sprinter is estimated to be 70 kg. Therefore the magnitude of the momentum of Olympic sprinter is estimated to be (70)(10) = 700 N s.
2	**D**	**A** shows **P + Q**, **B** shows – **P** – **Q**, **C** shows **Q** – **P**.
3	**A**	Initial speed is zero, meaning zero gradient at t = 0 (**A** or **D**) The ball gains speed as it falls so value of gradient increases with time (**A** or **D**). The height measured from the ground decreases with time (**A**).
4	**B**	Let the time taken for the oil tanker to stop be t. $800 + 0.5t - 0.5(10)t = 10 \Rightarrow t = 173.333$ s Deceleration = $\frac{10}{173.333} = 0.058$ m s^{-2}
5	**B**	Consider only the vertical components for motion of the golf ball from the ground to the maximum height. $\left[v^2 = u^2 + 2as\right] 0 = u^2 + 2(-9.81)(23) \Rightarrow u = 21.24$ m s^{-1} $\left[v = u + at\right] 0 = 21.24 + (-9.81)(t) \Rightarrow t = 2.165$ s Time of flight = (2)(2.165) = 4.33 s.
6	**A**	Constant velocity motion means zero acceleration therefore zero resultant force.
7	**B**	At t = 4 s, F = 20 N. Impulse Δp = area under the graph from t = 4 s to t = 6 s = $\frac{1}{2}(2)(20) = 20$ N s [$\Delta p = m\Delta v$] 20 = 20(Δv) $\Rightarrow$ Δv = 1.0 m s^{-1} Final velocity $v_f = v_i + \Delta v$ = 4.5 + 1.0 = 5.5 m s^{-1}
8	**B**	In one second, mass of bullets hitting the wall = mn momentum of bullets hitting the wall = mnu change in momentum of bullets = 2mnu = momentum imparted to wall = force on wall
9	**B**	The lift is moving upwards, but slowing down, so the acceleration is downwards. $mg - T = ma \Rightarrow T = mg - ma \Rightarrow T < mg$
10	**B**	Both objects have the same mass and experience the same acceleration. Object A: $10 - 4 - T = ma \Rightarrow 6 - T = ma$ Object B: $T - 2 = ma$ Solving simultaneously, T = 4 N
11	**B**	Horizontal component of tension in string balances static friction: $T\cos 30° = 1.8$ Vertical component of tension in string balances weight of block B: $T\sin 30° = W_B$ $\tan 30° = \frac{W_B}{1.8} \Rightarrow W_B = (1.8)(\tan 30°) = 1.04$ N
12	**D**	Power output = Fv where F is constant since a is uniform. Using $v^2 = u^2 + 2as$ and since u = 0, $v = \sqrt{2as}$ Therefore $P \propto \sqrt{s}$

JURONG JUNIOR COLLEGE
PHYSICS DEPARTMENT
2017 JC2 Preliminary Examination
8866 H1 Physics Paper 1 Solutions

Qn	Ans	Suggested solution
13	**D**	Since the sphere reaches a constant velocity, the kinetic energy must be constant. Hence the change in kinetic energy is zero. The gravitational potential energy is given by $E_P = mgh$ where *h* is the vertical height. Since the sphere is falling at velocity *v*, $h = h_0 - vt$ where h_0 is the initial height and is a constant. $E_P = mg(h_0 - vt) \quad \Rightarrow \quad \frac{dE_P}{dt} = -mgv$ Hence the gravitational potential energy decreases (as indicated by the negative sign) at a rate of *mgv*.
14	**C**	A - work done in expanding gas against atmospheric pressure B - work done results in change of energy from electrical to chemical C - no force involved, so no work done D - work done by component of weight leads to increase in kinetic energy.
15	**D**	 Using the potential method, assuming arbituary potential.
16	**A**	The current passing through Q and R is half of the current passing through P. Using $P = I^2R$, the power of Q and R should ¼ of P, thus the power of Q and R should be 2 W.
17	**A**	$I = \frac{Q}{t} = \frac{\rho ws}{t} = \rho wv$
		DC
18	**D**	When K is removed, the effective resistance of the lamps in parallel is higher, thus the p.d. across J will be lower, but the p.d. across J will be higher than the p.d across L and M.
19	**D**	p.d across XY= $\frac{3}{200 \times 10^3} \times 1.2 \times 10^6 = 18V$ Since potential of X is lower, thus the potential at X should be 3-18 = -15 V
20	**C**	A: Both particles have the highest KE at the equilibrium position. B: The particles moves up and down, not left or right. D: All the particles have the same total energy at all times.
21	**C**	$I \alpha \frac{1}{r^2}$ $I \alpha A^2$ Therefore $A \alpha \frac{1}{r}$ When the amplitude is doubled, the distance will be halved of the original.
22	**C**	Between 1st to 4th nodes is 1.5 wavelengths = 15 cm. Thus the wavelength is 10 cm.
23	**A**	A displacement node is a pressure anti-node and vice-versa.

JURONG JUNIOR COLLEGE
PHYSICS DEPARTMENT
2017 JC2 Preliminary Examination
8866 H1 Physics Paper 1 Solutions

Qn	Ans	Suggested solution
24	**C**	Since S_1Y and S_2Y are $n_1\lambda$ and $n_2\lambda$, thus $S_1Y - S_2Y = n\lambda$ where n is an integer
25	**C**	$\tau = Fd$ $= 2F_B \frac{L}{2}$ $= NBIL \times L$ $= 20 \times 0.01 \times 5 \times 10^{-3} \times (8 \times 10^{-3})^2$ $= 6.4 \times 10^{-8}$ N m
26	**B**	Since balance reading increases, force on magnet/balance is downwards. By Newton's 3rd law, force on wire is upwards. Using Fleming's Left Hand Rule, 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
27	**D**	Using the Right Hand Grip Rule, only a current at Q into the plane of the diagram would produce a magnetic field at O in the direction of OY.
28	**C**	As light intensity increases, the rate of incidence of photons increases. As rate of incidence of photons is proportional to the rate of emission of photoelectrons, the photocurrent increases proportionally as well.
29	**D**	$p = mv = \frac{h}{\lambda} \Rightarrow v = \frac{h}{mv}$ Hence, the most massive particle would have the smallest velocity.
30	**B**	Assuming range of wavelength for visible light to be 400 – 700 nm, the range of photon energies that would lead to visible spectral lines is about 1.8 – 3.1 eV. Since the gas is cold, the atom is at the ground state i.e. –13.6 eV level. Electrons of KE 13.00 eV would be able to excite it up to only the –0.850 eV level. From the –0.850 eV level, only the following transitions would lead to emission of photons with energies in the range of 1.8 – 3.1 eV. • from –0.850 eV to –3.40 eV level • from –1.51 eV to –3.40 eV level

JURONG JUNIOR COLLEGE
JC2 Preliminary Examination 2017

Name		Class	17S

PHYSICS **8866/02**

Higher 1

Structured Questions **25 August 2017**

2 hours

Candidates answer on the Question Paper.
No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

Do not open this booklet until you are told to do so.

Write your **name** and **class** in the spaces provided at the top of this page.

Write in dark blue or black pen.
You may use a soft pencil for any diagrams, graphs or rough working.
Do not use highlighters, glue or correction fluid.

Section A
Answer **all** questions.

Section B
Answer any **two** questions.

At the end of the examination, fasten all your work securely together.

The number of marks is given in brackets [ ] at the end of each question or part question.

For Examiner's Use	
Section A	
1	
2	
3	
4	
5	
Section B	
6	
7	
8	
Total	

(This question paper consists of 23 printed pages)

Data

speed of light in free space,	c	$= 3.00 \times 10^{8}$ m s^{-1}
elementary charge,	e	$= 1.60 \times 10^{-19}$ C
the Planck constant,	h	$= 6.63 \times 10^{-34}$ J s
unified atomic mass constant,	u	$= 1.66 \times 10^{-27}$ kg
rest mass of electron,	m_e	$= 9.11 \times 10^{-31}$ kg
rest mass of proton,	m_p	$= 1.67 \times 10^{-27}$ 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	$= \rho g h$
resistors in series,	R	$= R_1 + R_2 + \ldots$
resistors in parallel,	$1/R$	$= 1/R_1 + 1/R_2 + \ldots$

Section A

Answer **all** questions in this section.

1 Fig. 1 shows an experimental setup used to measure the acceleration of free fall.

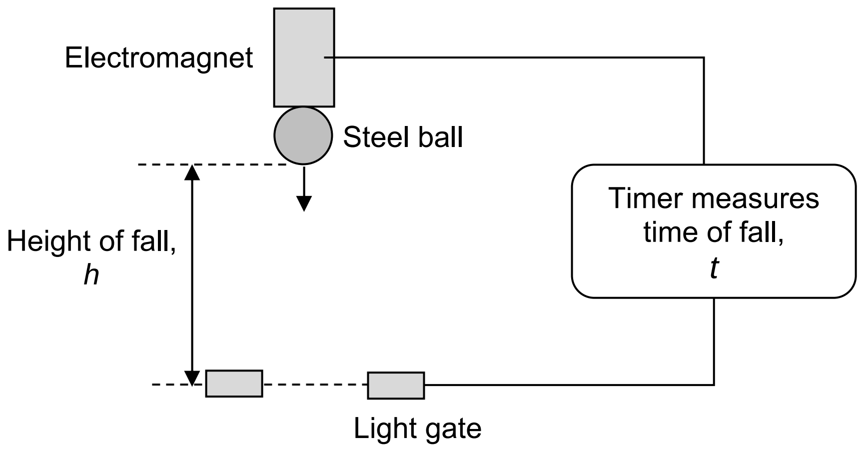


Fig. 1

The steel ball is suspended at the top by an electromagnet. The electronic timer starts when the electromagnet is turned off. As the steel ball falls by height h and goes through the light gate, the timer stops and displays the time of fall, t.

Only one set of data was collected:

$$h = (0.600 \pm 0.001)\ \text{m}$$

$$t = (354 \pm 1)\ \text{ms}$$

The acceleration of free fall is calculated to be 9.5758 m s^{-2}.

(a) Express the acceleration of free fall with its associated uncertainty.

acceleration of free fall = (................ ± ....) m s^{-2} [2]

(b) It was later found out that when the electromagnet was turned off, there is some constant delay before the steel ball starts falling.

(i) Suggest a cause for this delay.

....

....

.... [1]

(ii) State and explain the type of error caused by this delay.

....

....

....

.... [2]

(iii) Suggest how this delay can be determined.

....

....

....

.... [2]

2 **(a)** Two objects, P and Q, of masses 1.5 kg and 0.30 kg respectively, are connected by a string that passes over a pulley as shown in Fig. 2.1. The pulley is frictionless and the string is inelastic. Object P rests on a horizontal hard surface.

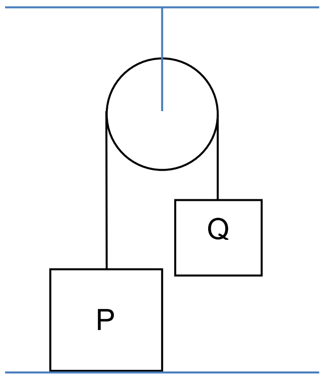


Fig. 2.1

(i) Draw the forces acting on objects P and Q. [3]

(ii) Show that the contact force between the horizontal hard surface and object P is 12 N. [2]

(b) The setup in **(a)** was modified such that object P rests horizontally on a spring as shown in Fig. 2.2. The spring is compressed by 2.0 cm.

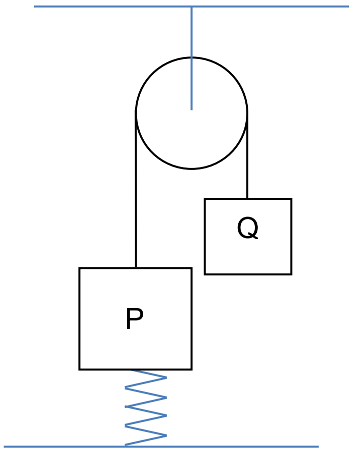


Fig. 2.2

(i) State *Hooke's law*.

....

....

.... [1]

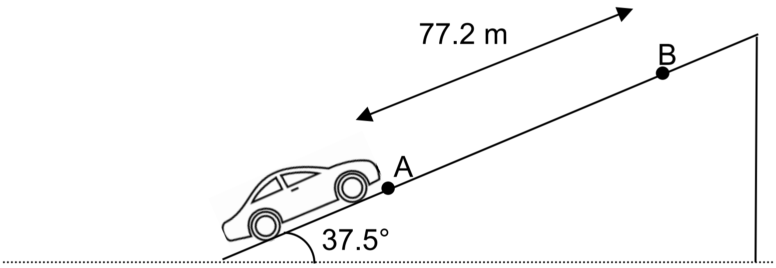
(ii) Determine the force constant of the spring.

force constant of spring = ... N m^{-1} [1]

(iii) Determine the elastic potential energy stored in the spring.

elastic potential energy = ... J [2]

3 A drunk tourist at a ski resort drives his 1800 kg car up a snow-covered ski-jump at a constant speed of 60 km h^{-1} between points A and B as shown in Fig. 3.1. The ski-jump is inclined at an angle of 37.5° and points A and B are 77.2 m apart.



(Not drawn to scale)

Fig. 3.1

(a) Define *power*.

....

.... [1]

(b) Determine the minimum power required for the car to perform the feat.

minimum power = ... kW [3]

(c) At point B, a braking mechanism enables the car to be held at that position when it is stationary. If the braking mechanism suddenly fails and the car slides down the ski jump, calculate its speed when it reaches point A.

speed = ... m s^{-1} [2]

4 Fig. 4.1 shows a wire frame ABCD supported on two knife-edges P and Q so that the section PBCQ of the frame lies within a solenoid. Side BC has a length of 5.0 cm and QC has a length of 12.0 cm.

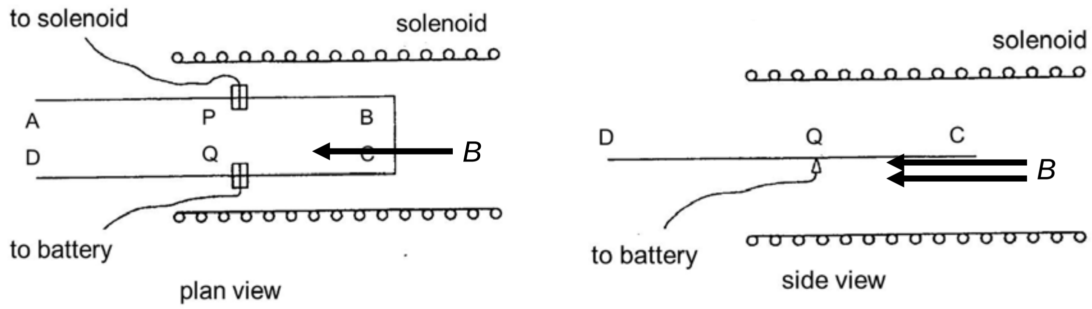


Fig. 4.1

Electrical connections are made to the frame through the knife-edges so that the part PBCQ of the frame and the solenoid can be connected in series with a battery. When there is no current in the circuit, the frame is horizontal.

(a) When the frame is horizontal and a current passes through both the frame and solenoid, the magnetic flux density *B* of the solenoid in the region of side BC of the frame is towards the left and the current flows from B to C.

State and explain the direction of the force, if any, due to the magnetic field of the solenoid acting on

(i) side BC, and

....

....

.... [2]

(i) side AB.

....

.... [1]

(b) **(i)** The solenoid has 700 turns m^{-1} and carries a current of 3.5 A.

The magnetic flux density B on the axis of a long solenoid is $B = \mu_0 nI$, where n is the number of turns of the coil per unit length.

Calculate the magnetic flux density in the region of side BC of the frame.

magnetic flux density = ... T [1]

(ii) Determine the force acting on BC due to the magnetic field in the solenoid.

force acting on BC = ______________________ N [2]

(iii) A small piece of paper of mass 0.100 g is placed on the side DQ and positioned so as to keep the frame horizontal.

Determine the distance *d* from the knife-edge the paper must be positioned.

distance *d* = ______________________ m [2]

(iv) The current through both the solenoid and frame is doubled.

State and explain the changes, if any, that must be made to the mass of the piece of paper in order to keep the frame horizontal.

....

....

....

....

.... [2]

5 **(a)** With reference to the photoelectric effect, state what is meant by *work function* of a metal.

....

....

.... [1]

(b) In an experiment to investigate the photoelectric effect, a student measures the wavelength λ of the light incident on a metal surface and the maximum kinetic energy E_{max} of the emitted electrons. The variation with E_{max} of λ is shown in Fig. 5.1.

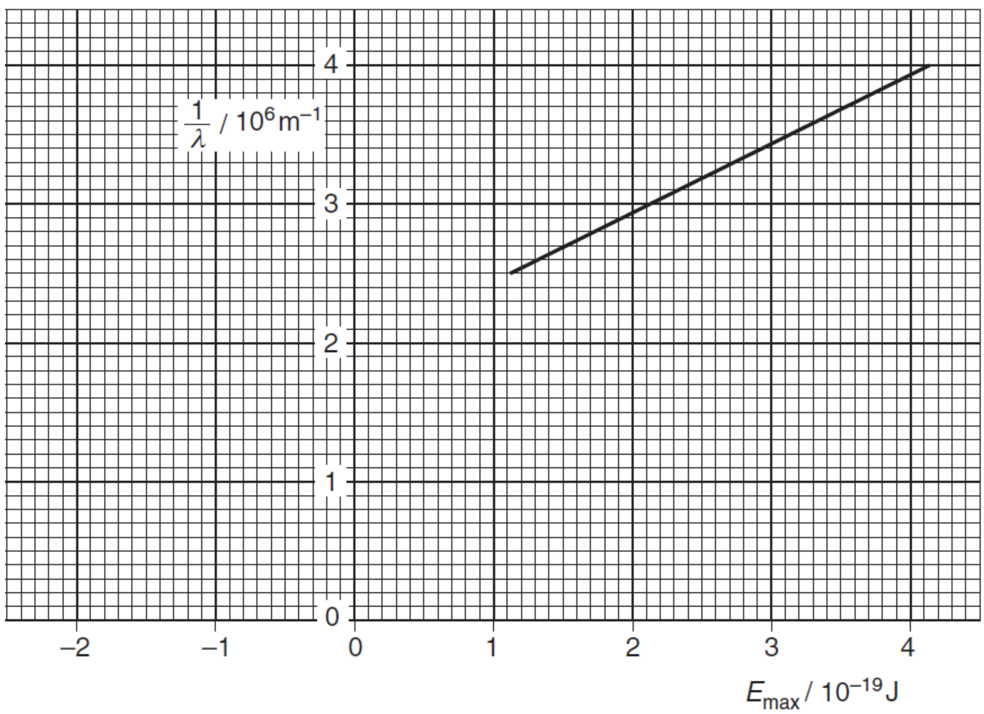


Fig. 5.1

(i) Einstein's photoelectric equation may be expressed as

$$\frac{hc}{\lambda} = E_{\text{max}} + \phi$$

where ϕ is the work function of the metal, h is the Planck constant and c is the speed of light.

Show that the threshold frequency f_0 of the metal is approximately 5.9×10^{14} Hz. [2]

(ii) On Fig. 5.1, sketch a second graph to represent the results for an experiment using a metal plate of higher work function. Label this graph **W**. [1]

(c) If the intensity of the light is increased while keeping the frequency constant, state and explain the effect, if any, on the

1. number of electrons emitted per unit time; and

....

....

.... [1]

2. the maximum kinetic energy of these emitted electrons.

....

....

....

....

....

.... [3]

Section B

Answer **two** questions from this section.

6 Fig. 6.1 shows a smooth table on which there are two objects A and B of masses 1.0 kg and 2.5 kg respectively. Object B is initially stationary. Object A is moving to the right towards object B and hits it at a speed of 5.0 m s^{-1}. The collision is elastic.

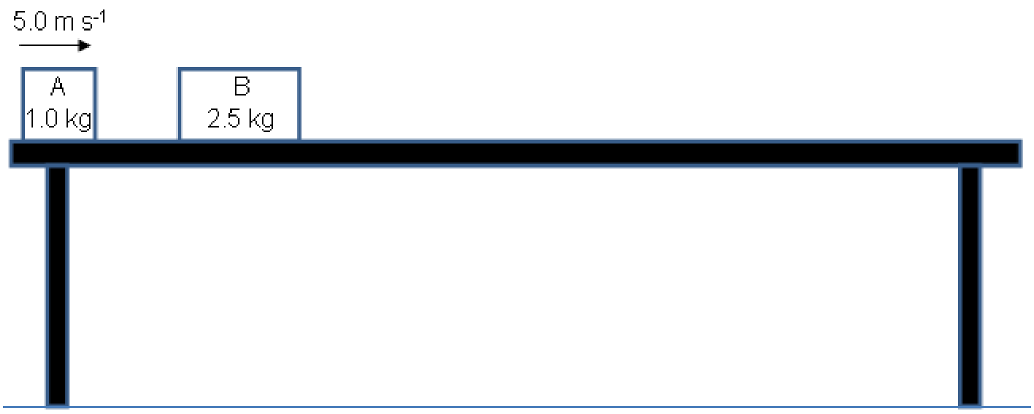


Fig. 6.1

(a) **(i)** State two characteristics unique to elastic collisions. [2]

1. ....

....

2. ....

....

(ii) Determine the final velocity of object A and show that the final velocity of object B is 2.9 m s^{-1} after the collision. [4]

final velocity of object A = ... m s^{-1}

(b) **(i)** Define *displacement*.

....

.... [1]

(ii) Define *acceleration*.

....

.... [1]

(c) After the collision, object B slides on the horizontal smooth table surface before falling off the edge of the table with a horizontal velocity of 2.9 m s^{-1}. Object B lands in the middle of a sand bath whose top surface is 0.70 m below the top surface of the table as shown in Fig. 6.2. Assume air resistance is negligible.

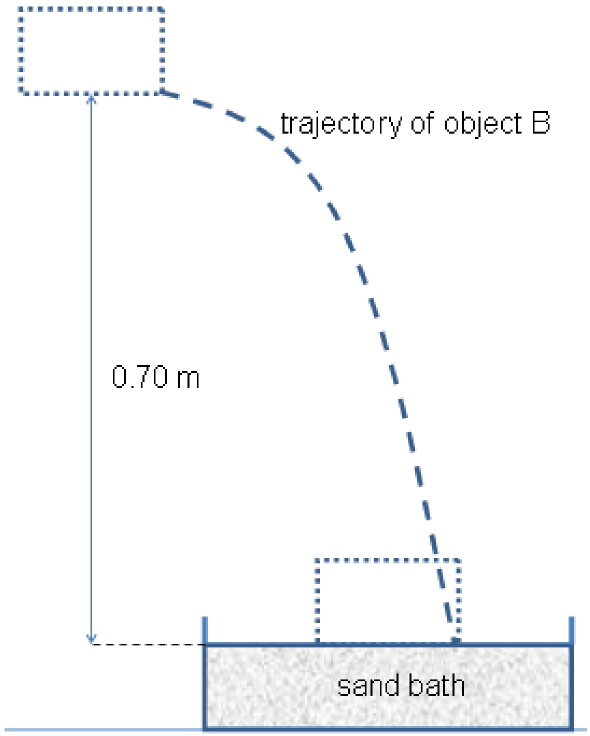
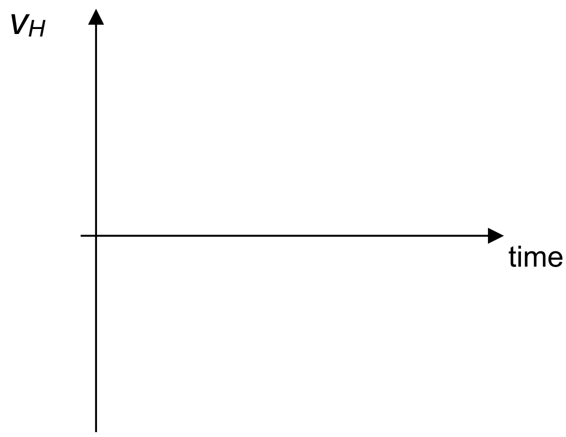


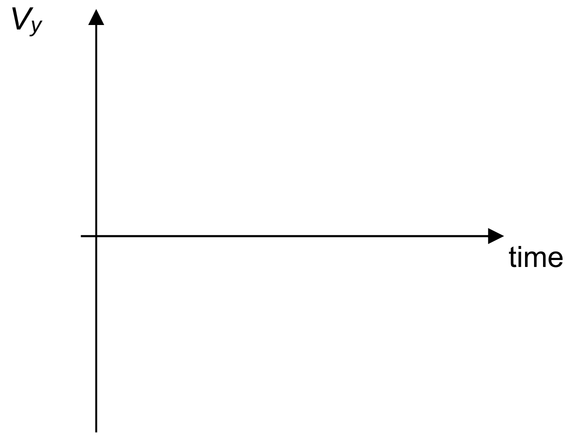
Fig 6.2

Sketch graphs of the following quantities for object B from the time it falls off the edge of the table to the time it lands on the sand bath.

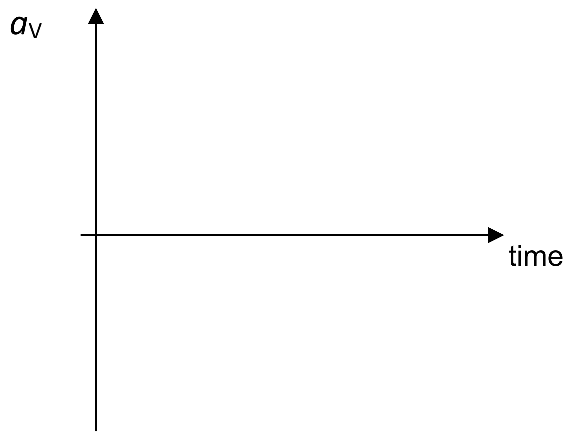
(i) The variation with time of its horizontal component of velocity v_H. [1]



(ii) The variation with time of its vertical component of velocity v_y. [1]



(iii) The variation with time of its vertical acceleration a_y. [2]



(iv) Determine the horizontal distance from the edge of the table moved by object B when it just hits the sand bath.

horizontal distance = ... m [4]

(v) Determine the vertical speed of object B when it just hits the surface of the sand.

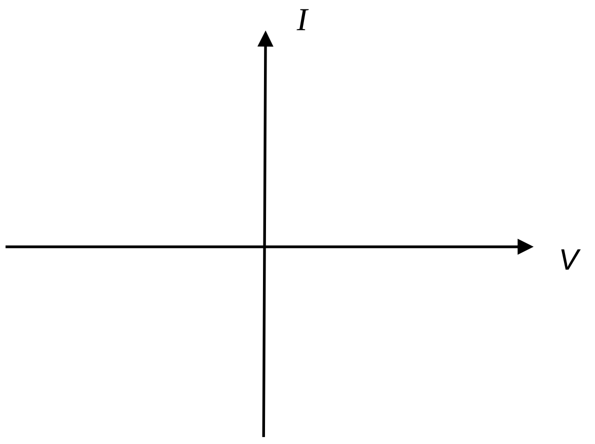
vertical speed of object B = ... m s^{-1} [2]

(d) Object B is eventually embedded in the sand bath, entering vertically by 12 cm. Assuming the vertical retarding force on object B is constant as it enters the sand, determine the average deceleration of object B as it enters the sand.

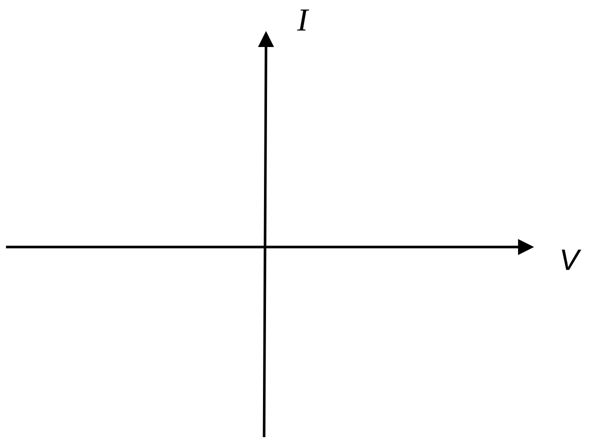
average deceleration of object B = ... m s^{-2} [2]

7 **(a)** Sketch the current-voltage (I-V) characteristics of

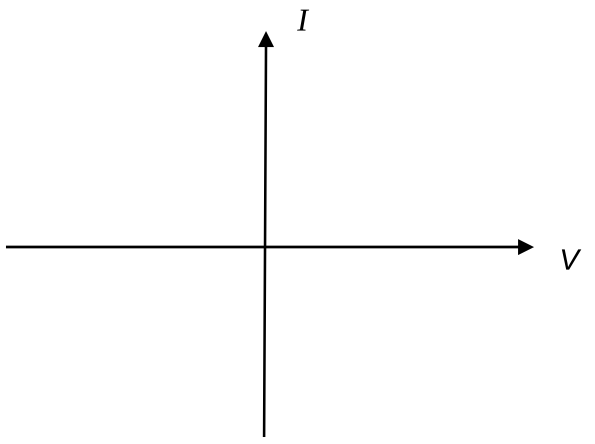
(i) a metallic conductor at constant temperature, [1]



(ii) An ideal semiconductor diode, [1]



(iii) and a non-ideal semiconductor diode. [1]



(b) The I-V characteristic of a 12 V car headlamp is drawn in Fig. 7.1. Only positive values of V and I are shown.

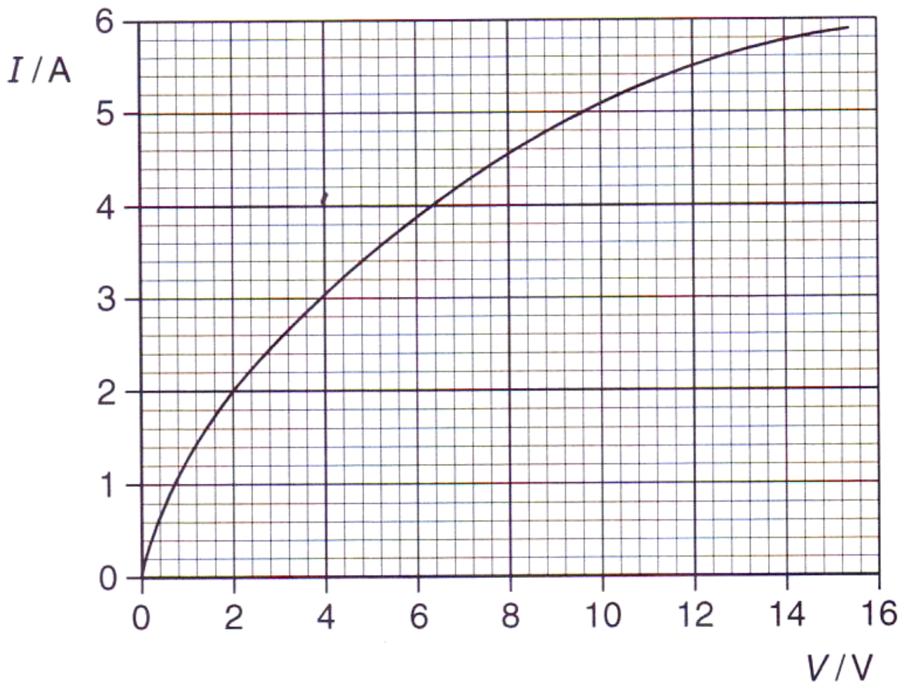


Fig. 7.1

(i) State why the graph stops at V = 15.4 V.

....

....

....

.... [1]

(ii) Deduce the resistance of the headlamp at 2 V and 10 V.

resistance at 2 V = ... Ω

resistance at 10 V = ... Ω [3]

(iii) Explain in terms of the movement of charged particles why the resistance increases with potential difference as shown in Fig. 7.1.

[2]

(c) The filament of a headlamp could be manufactured from a straight piece of tungsten wire of diameter 0.084 mm.

(i) Calculate the length of wire required for a resistance of 0.50 Ω when the wire is at room temperature. The resistivity of tungsten at room temperature is 5.5×10^{-8} Ω m.

length = ... m [4]

(ii) Explain why this straight length of wire is not practical.

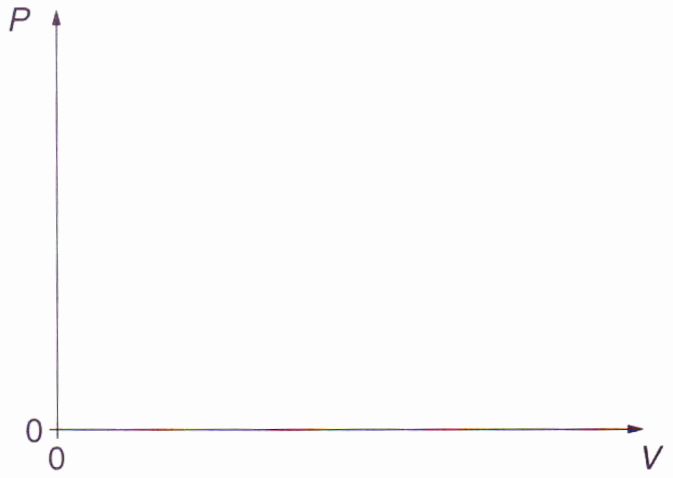
[1]

(iii) Suggest two ways of making a filament wire more practical. [2]

1.

2.

(d) Sketch a graph to show the variation with voltage V of the power P supplied to the headlamp. [2]



(e) When the headlamp is operating at 4.0 V, the heat loss is 4.0 W.

Determine the efficiency of the headlamp.

efficiency = ______________ % [2]

8 **(a)** A student sets up the apparatus illustrated in Fig. 8.1 in order to observe two-source interference fringes. The double slit with slit separation 0.800 mm, situated 2.50 m from the screen, is illuminated with coherent light of wavelength 690 nm. Fringes are observed on the screen.

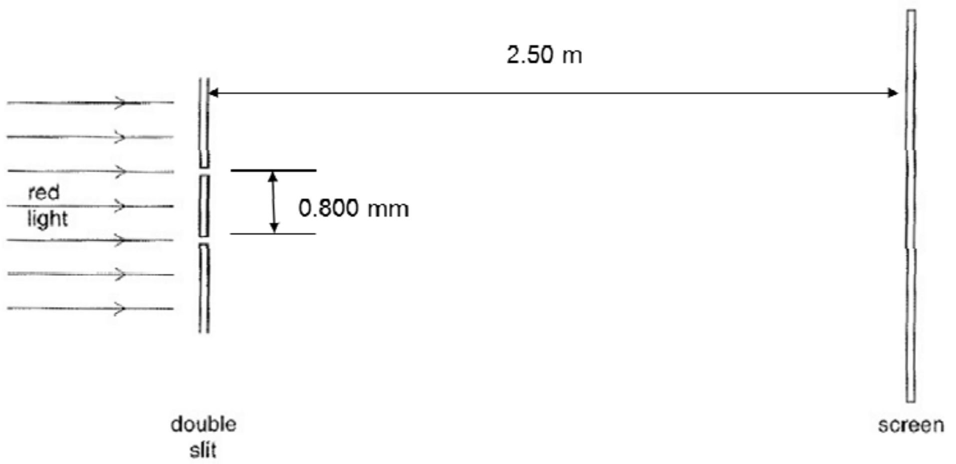


Fig. 8.1

(i) Explain the meaning of *coherent* light.

....

.... [1]

(ii) Calculate the separation of the fringes.

separation = ... m [3]

(iii) State and explain what change, if any, occurs in the separation of the fringes and in the contrast between bright and dark fringes observed on the screen, when each of the following changes is made separately.

1. increasing the intensity of the red light incident on the double slit

[2]

2. increasing the distance between the double slit and the screen

[3]

3. changing the red light into green light

[2]

(b) **(i)** What conditions must be satisfied in order that two source interference fringes may be observed? [2]

1.

2.

(b) **(ii)** Two sound sources which are 2.00 m apart are set up at **A** and **B** as shown in Fig. 8.2. The perpendicular distance between **AB** and **XY** is 12.0 m. A student attempts to determine the wavelength of the sound from the sources at **A** and **B** using the practical method. He walks along **XY** and detects sound of *minimum* intensity at **P** using a microphone connected to a cathode ray oscilloscope. The next position where he detects sound of *minimum* intensity is at **Q**. The distance **PQ** is 6.00 m.

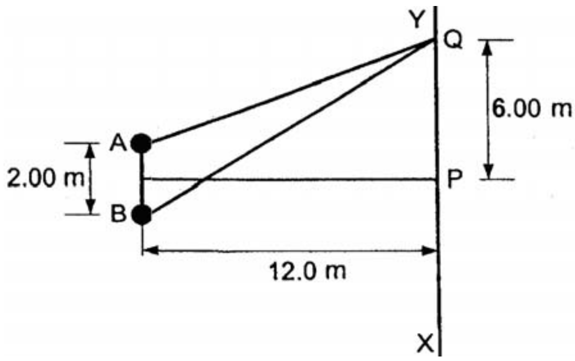


Fig. 8.2

1. Determine the phase difference of the waves at sources A and B.

phase difference = ... rad [1]

2. Write down the phase difference between the waves arriving at **Q**.

phase difference = ... rad [1]

3. Determine the path difference between the waves arriving at **Q** in 3 decimal places.

path difference = ... m [2]

4. Hence deduce the wavelength of the sound from the sources **A** and **B** using this practical method.

wavelength = ______________ m [1]

5. Another student chooses to determine the wavelength of the sound from the sources **A** and **B** theoretically, by using the formula for the double-slit interference pattern.

Which wavelength value, obtained in **(b)(ii)4.** using the practical method or obtained using the theoretical method, is less accurate? Explain.

____

____

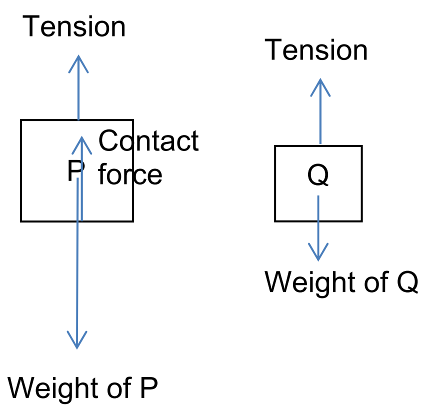
____

____

____ [2]

The End

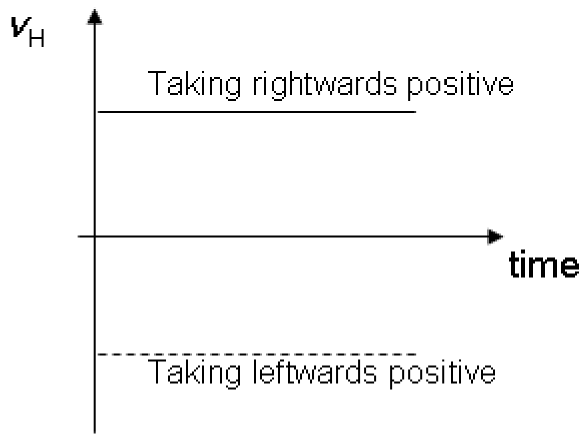
JURONG JUNIOR COLLEGE
PHYSICS DEPARTMENT
2017 JC2 Preliminary Examination
8866 H1 Physics Paper 2
Suggested Solutions with Markers' Comments

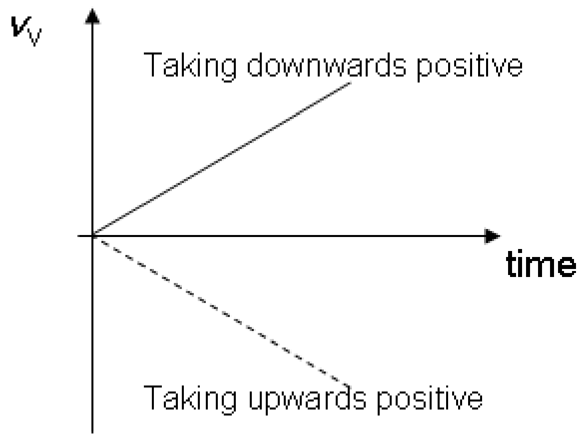
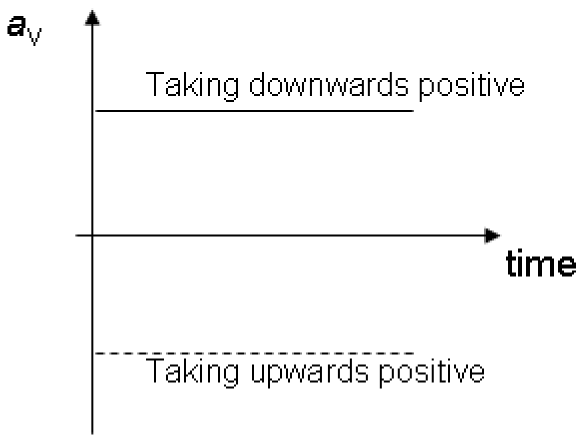
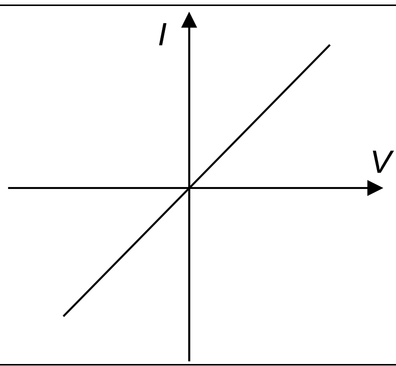
Qn	Suggested solution (Font Arial, 11 pt)	Remarks
1(a)	Using $s = ut + \frac{1}{2}at^2 \rightarrow h = \frac{1}{2}at^2$ $\frac{\Delta a}{a} = \frac{\Delta h}{h} + \frac{2\Delta t}{t}$ $\frac{\Delta a}{9.5758} = \frac{0.001}{0.600} + \frac{2(1)}{354}$ $\Delta a = 0.07$ m s^{-2} $a = (9.58 \pm 0.07)$ m s^{-2}	**[1] ans: uncertainty** **[1] e.c.f. final expression (correct s.f. for uncertainty, correct d.p. for acceleration of free fall)**
(b)(i)	The delay is due to the time taken for the electromagnet and steel ball to lose their magnetism.	**[1]**
(ii)	Systematic error. The constant delay causes the timing measured to be consistently too long.	**[1]** **[1]**
(iii)	Graphical methiod: Measure the timings for different heights of fall and plot a graph of *h* against t^2. Details: The constant delay is the square root of the x-intercept. <u>OR</u> Experimental method: Use of light gates / high speed camera / etc. Details: Positioning of light gates / view video in slow motion / etc.	**[1] accept graphical or experimental method** **[1] relevant details**
2(a)(i)		**[2] for 3 forces on P, [1] for 2 forces on Q. Minus 1 mark if no label and/or wrong point(s) of application and/or wrong relative magnitudes showing non-equilibrium.**
(ii)	Object Q: tension balances the weight of object Q Object P: tension + contact force balances the weight of object P (0.3)(9.81) + contact force = (1.5)(9.81) Contact force = (1.2)(9.81) = 11.8 = 12 N (shown)	**[1] equate tension to weight of object Q** **[1] sub**
(b)(i)	Hooke's Law states that the <u>extension</u> (or compression) of a spring is <u>proportional</u> to the <u>force required to extend</u> (or compress) it, <u>provided the limit of proportionality is not exceeded</u>.	**[1]**
(ii)	12 = (*k*)(0.020) *k* = 600 N m^{-1}	**[1] ans**
(iii)	EPE = $\frac{1}{2}kx^2$ = $\frac{1}{2}(600)(0.020)^2$ = 0.12 J	**[1] sub** **[1] ans**
3(a)	Power is defined as the <u>rate of work done/ work done per unit time/ rate of energy conversion</u>.	**[1]**

JURONG JUNIOR COLLEGE
PHYSICS DEPARTMENT
2017 JC2 Preliminary Examination
8866 H1 Physics Paper 2
Suggested Solutions with Markers' Comments

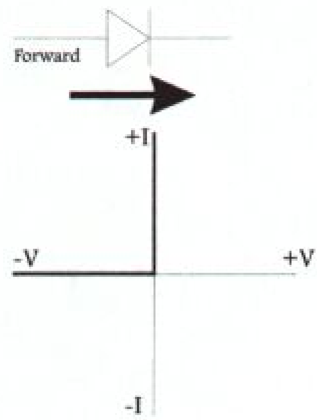
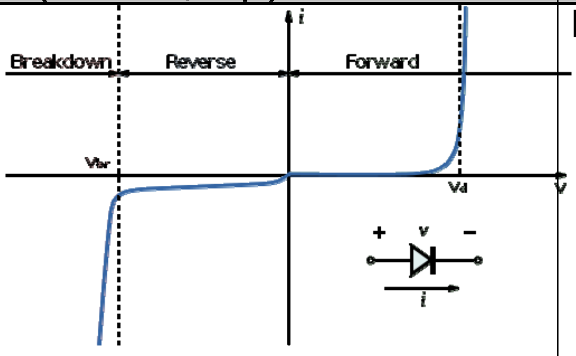
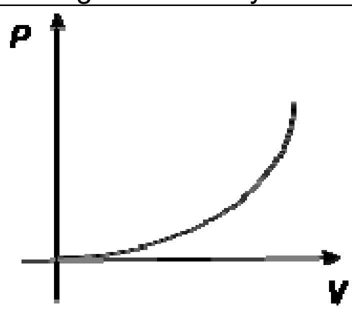
Qn	Suggested solution (Font Arial, 11 pt)	Remarks
(b)	For car to move at constant velocity, the minimum engine force required must be equal in magnitude to component of car's weight along slope. Hence, $F = mg\sin\theta$ $= (1800)(9.81)\sin(37.5°)$ $=1.07 \times 10^4$ N Minimum power $P = Fv = (1.07 \times 10^4)(60 \times 10^3/3600)$ $= 179$ kW	 **[1]-sub** **[1]-sub** **[1]-ans**
(c)	Gain in KE = Loss in GPE $\frac{1}{2} mv^2 = mgh$ $\frac{1}{2} v^2 = (9.81)(77.2 \sin 37.5°)$ $v = 30.4$ ms^{-1}	 **[1]-sub** **[1]-ans**
4(a)(i)	Magnetic force is acting **downward**. Since **side BC is perpendicular to the magnetic field** *B* of the solenoid, it would **experience a magnetic force whose direction is given by Fleming's Left Hand Rule**.	**[1]** **[1]**
(a)(ii)	Since side AB is **parallel with the magnetic field** *B* of the solenoid, **no magnetic force** acts on it.	**[1]**
(b)(i)	$B = \mu_0 nI$ $= 4\pi \times 10^{-7} \times 700 \times 3.5$ $= 3.08 \times 10^{-3}$ T	 **[1] ans**
(b)(ii)	Force acting on BC $F = BIL$ $= 3.08 \times 10^{-3} \times 3.5 \times 5.0 \times 10^{-2}$ $= 5.39 \times 10^{-4}$ N	 **[1] sub** **[1] ans**
(b)(iii)	Since frame is horizontal, applying Principle of Moments, Sum of anti-clockwise moments = Sum of clockwise moment $mgd = Fd_{QC}$ $(0.100 \times 10^{-3})(9.81)(d) = (5.39 \times 10^{-4})(12 \times 10^{-2})$ $d = 0.0659$ m	 **[1] sub** **[1] ans**
(b)(iv)	The **clockwise moment will increase by 4 times** as the magnetic flux density of the solenoid and current are doubled. The mass of the paper must be **increased by 4 times** so that the anticlockwise moment will be increased by 4 times.	**[1]** **[1]**
5(a)	Work function is the <u>minimum energy required to liberate/emit an electron</u> from the surface.	**[1]**
(b)(i)	From (b)(i), $hc/\lambda = hf_0 + E_{MAX}$ when $E_{MAX} = 0$, $1/\lambda_0 = 1.95 \times 10^6$ m^{-1} (allow $\pm 0.05 \times 10^6$ m^{-1}) (<u>evidence</u> of use of y-intercept from graph) $f_0 = c(1/\lambda_0) = (3.00 \times 10^8)(1.95 \times 10^6)$ $= 5.85 \times 10^{14}$ Hz **OR:** chooses point on the line and substitutes values of $1/\lambda$ and E_{MAX} into $hc/\lambda = \Phi + E_{MAX}$	 **[1] method** **[1] sub**
(b)(ii)	Same gradient, towards left of original graph (implying larger y-intercept)	**[1]**

JURONG JUNIOR COLLEGE
PHYSICS DEPARTMENT
2017 JC2 Preliminary Examination
8866 H1 Physics Paper 2
Suggested Solutions with Markers' Comments

Qn	Suggested solution (Font Arial, 11 pt)	Remarks
(c)	($I = \frac{Nhf}{tA} \Rightarrow$ when I increases, it can mean $\frac{N}{t}$ increases or *f* increases.) (1) Number of electrons emitted per unit time increases because there are now more photons striking the metal surface per unit time. (2) E_{MAX} of emitted photoelectron is the same as photon-electron interaction is 1 to 1, and since *f* is fixed, energy of photon absorbed by electron is constant and for same surface with same work function.	 **[1]** **[1]** **[1]** **[1]**
6(a)(i)	1. Total kinetic energy is conserved. 2. Relative speed of separation = relative speed of approach	**[1]** **[1]**
(ii)	Total final momentum = total initial momentum $v_A + 2.5\ v_B = 5$ Relative speed of separation = relative speed of approach $v_B - v_A = 5$ Solving simultaneously, $v_A = -2.143 = -2.1$ m s^{-1} $v_B = 2.857 = 2.9$ m s^{-1} (shown)	 **[1] eqn** **[1] eqn** **(also accept eqn of KE conservation)** **[1] working** **[1] v_A ans (must be –ve)**
(b)(i)	Displacement is defined as the linear distance in a specified direction from a reference point.	**[1] defn**
(ii)	Acceleration is defined as the rate of change of velocity.	**[1] defn**
(c)(i)		**[1]**

Qn	Suggested solution (Font Arial, 11 pt)	Remarks
(ii)		**[1]**
(iii)		**[1]** **[1] this fourth mark is awarded for consistent convention used in (ii) and (iii)**
(iv)	Consider the vertical motion to determine time of flight: $s = ut + \frac{1}{2}at^2$ $0.7 = \frac{1}{2}(9.81)t^2$ $t = 0.378$ s Consider the horizontal motion to determine horizontal distance traveled: $s = (2.9)(0.378)$ $= 1.1$ m	**[1] sub** **[1] ans** **[1] sub** **[1] ans**
(v)	Consider the vertical motion: $v = u + at = 0 + (9.81)(0.378) = 3.71$ m s^{-1}	**[1] sub** **[1] ans**
(d)	Consider the vertical motion: $v^2 = u^2 + 2as$ $0 = (3.71)^2 + 2a(0.12)$ $a = -57.3$ m s^{-2} deceleration = 57.3 m s^{-2}	**[1] sub** **[1] ans (must be +ve)**
7(a)(i)		**[1]**

JURONG JUNIOR COLLEGE
PHYSICS DEPARTMENT
2017 JC2 Preliminary Examination
8866 H1 Physics Paper 2
Suggested Solutions with Markers' Comments

Qn	Suggested solution (Font Arial, 11 pt)	Remarks
(a)(ii) (iii)	 Ideal Diode  Practical Diode	[2]
(b)i)	The maximum potential difference that the car battery can be applied across the headlamp cannot be more than 15.4 V, beyond which the filament breaks.	[1]
(b)ii)	From the graph, at 2.0 V, I = 2.0 A → R = 1.00 Ω From the graph, at 10.0 V, I = 5.1 A → R = 1.96 Ω	[1] [1] Correct reading [1] Ans
(b)iii)	• Lattice ions in the metal to vibrate more vigorously, causing an increased rate of collision with the moving electrons. • The increased rate of collision reduces the rate of flow of electrons, hence, lowering the current flow.	[1] [1]
c)i)	$R = \frac{\rho \ell}{A} = \frac{4\rho \ell}{\pi d^2}$ $0.50 = \frac{4(5.5\times10^{-8})\ell}{\pi(0.084\times10^{-3})^2} \Rightarrow \ell = 0.0504$ m	[1] Value of A [1] Eqn [1] Subs [1] Ans
c)ii)	The length of the filament wire is **too long** to be placed inside the filament lamp.	[1]
c)iii)	The wire should be **coiled** instead of using a straight wire. A **thinner wire** could be used instead, so that a shorter wire can be used. Metal of higher resistivity could be used, so that a shorter wire can be used.	[2] Any 2
d)		[1] correct shape [1] pass through origin
e)	At V = 4 V, I = 3 A Total power= 12 W Efficiency= $\frac{12-4}{12}\times100\% = 67\%$	[1] Method [1] Ans
8(a)(i)	The waves have a constant phase difference.	[1]
(a)(ii)	Using $x = \frac{\lambda D}{a} = \frac{690\times10^{-9}\times2.5}{0.800\times10^{-3}} = 2.16\times10^{-3} m$	[1] Formula [1] Subst [1] Ans

JURONG JUNIOR COLLEGE
PHYSICS DEPARTMENT
2017 JC2 Preliminary Examination
8866 H1 Physics Paper 2
Suggested Solutions with Markers' Comments

Qn	Suggested solution (Font Arial, 11 pt)	Remarks
(a)(iii)1.	There is no change in the spacing. The maxima is the brighter and thus the contrast is higher.	**[1]** **[1]**
2.	Since D is larger, x will be larger. The separation will increase. The maxima is dimmer due to the longer distance, thus the contrast is lower.	**[1]** **[2]**
3.	Since wavelength of green light is shorter, x will be smaller. The separation will decrease.	**[1]** **[1]**
(b)i)	1. The waves from the two sources are coherent. 2. The waves from the two sources have approximately the same amplitude. 3. The waves from the two sources must meet. 4. The waves must be unpolarized or polarized in the same plane.	**[2] Any two**
(b)(ii)1.	π rad	**[1]**
(b)(ii)2.	π rad	**[1]**
(b)(ii)3.	Path length AQ $= \sqrt{(12)^2 + (5)^2} = 13.000 \text{ m}$ Path length BQ $= \sqrt{(12)^2 + (7)^2} = 13.892 \text{ m}$ Path difference $= 13.892 - 13.000 = 0.892 \text{ m}$	**[1]** **[1]**
(b)(ii)4.	Wavelength = path difference in (b)(ii)3**.** = 0.892 m	**[1]**
(b)(ii)5.	The wavelength value in (d) is less accurate because *D* must be much larger than *x* in the double-slit interference pattern formula.	**[2] or zero**