Name	Class	Index Number

PIONEER JUNIOR COLLEGE
JC2 Preliminary Examination

PHYSICS **9646/01**
Higher 2

Paper 1 Multiple Choice

27 September 2013

1 hour 15 minutes

Additional Material: 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, class and index number on the Answer Sheet in the spaces provided.

There are **forty** 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 document consists of **18** printed pages.

Data

speed of light in free space,	$c = 3.00 \times 10^{8}\ \mathrm{m\,s^{-1}}$
permeability of free space,	$\mu_0 = 4\pi \times 10^{-7}\ \mathrm{H\,m^{-1}}$
permittivity of free space,	$\varepsilon_0 = 8.85 \times 10^{-12}\ \mathrm{F\,m^{-1}}$
	$= (1/(36\pi)) \times 10^{-9}\ \mathrm{F\,m^{-1}}$
elementary charge,	$e = 1.60 \times 10^{-19}\ \mathrm{C}$
the Planck constant,	$h = 6.63 \times 10^{-34}\ \mathrm{J\,s}$
unified atomic mass constant,	$u = 1.66 \times 10^{-27}\ \mathrm{kg}$
rest mass of electron,	$m_e = 9.11 \times 10^{-31}\ \mathrm{kg}$
rest mass of proton,	$m_p = 1.67 \times 10^{-27}\ \mathrm{kg}$
molar gas constant,	$R = 8.31\ \mathrm{J\,K^{-1}\,mol^{-1}}$
the Avogadro constant,	$N_A = 6.02 \times 10^{23}\ \mathrm{mol^{-1}}$
the Boltzmann constant,	$k = 1.38 \times 10^{-23}\ \mathrm{J\,K^{-1}}$
gravitational constant,	$G = 6.67 \times 10^{-11}\ \mathrm{N\,m^{2}\,kg^{-2}}$
acceleration of free fall,	$g = 9.81\ \mathrm{m\,s^{-2}}$

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,	$p = \rho gh$
gravitational potential,	$\phi = -\frac{Gm}{r}$
displacement of particle in s.h.m.,	$x = x_0 \sin \omega t$
velocity of particle in s.h.m.,	$v = v_0 \cos \omega t$ $= \pm\omega\sqrt{x_0^{\,2} - x^2}$
mean kinetic energy of a molecule of an ideal gas,	$E = \frac{3}{2}kT$
resistors in series,	$R = R_1 + R_2 + \ldots$
resistors in parallel,	$1/R = 1/R_1 + 1/R_2 + \ldots$
electric potential,	$V = \frac{Q}{4\pi\varepsilon_0 r}$
alternating current/voltage,	$x = x_0 \sin \omega t$
transmission coefficient,	$T = \exp(-2kd)$ where $k = \sqrt{\frac{8\pi^2 m(U-E)}{h^2}}$
radioactive decay,	$x = x_0 \exp(-\lambda t)$
decay constant,	$\lambda = \frac{0.693}{t_{\frac{1}{2}}}$

1 What are the SI base units of magnetic flux density?

A $kg\,m\,s^{-2}\,A^{-1}$

B $kg\,m^{2}\,s^{-2}\,A^{-1}$

C $kg\,s^{-2}\,A^{-1}\,rad^{-1}$

D $kg\,s^{-2}\,A^{-1}$

2 A boat changes its velocity from 5 $m\,s^{-1}$ due East to 7 $m\,s^{-1}$ due South.

What is its change in velocity?

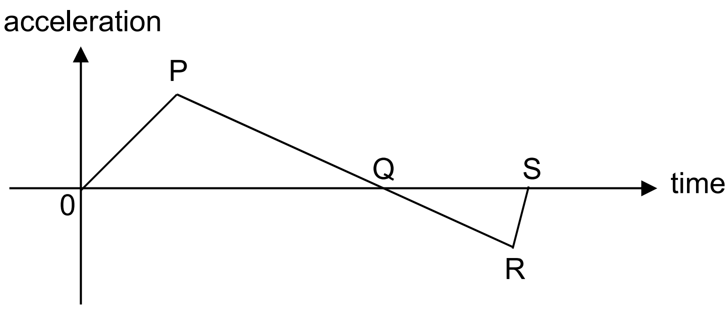
A 9 $m\,s^{-1}$ at a direction of 54° South of East

B 9 $m\,s^{-1}$ at a direction of 54° South of West

C 2 $m\,s^{-1}$ at a direction of 36° East of South

D 2 $m\,s^{-1}$ at a direction of 36° West of South

3 The acceleration-time graph of an object moving in a straight line is as shown.



If the object starts its motion from rest, at which point is the object moving with the largest speed?

A P **B** Q **C** R **D** S

4 An athlete throws a javelin at an angle of 60° to the horizontal. The javelin leaves the athlete's hand with an initial kinetic energy, *E*.

Neglecting air resistance, the javelin's kinetic energy at its highest point of motion is

A zero. **B** $\frac{1}{4}E$. **C** $\frac{3}{4}E$. **D** *E*.

5 Which body is in equilibrium?

A A satellite moving around the Earth in a circular orbit.

B A car rolling down a frictionless inclined plane.

C An apple falling freely towards the surface of Earth.

D A block sliding at constant velocity across a tabletop.

6 A mass of 2.0 kg is at rest on a smooth floor. A horizontal stream of water, travelling at speed 8.0 m s^{-1}, strikes it at a rate of 1.0 kg s^{-1} for a duration of 50 s without splashing.

What is the initial acceleration of the mass?

A 0.080 m s^{-2}

B 0.16 m s^{-2}

C 4.0 m s^{-2}

D 8.0 m s^{-2}

7 A barge is floating in seawater of density 1030 kg m^{-3}. The area of the horizontal cross-section of barge is 97 m^2 and the sides of the barge are vertical. The flat-bottom of the barge is 70 cm under seawater when it is loaded with 2.0×10^4 kg of cargo.

How deep is the bottom of the barge below the water surface when the cargo is unloaded off the barge?

A 20 cm

B 50 cm

C 70 cm

D 90 cm

8 A spring obeying Hooke's law has an unstretched length of 60 mm and a spring constant of 500 N m^{-1}.

What is the tension in the spring when its overall length is 90 mm?

A 15 N

B 45 N

C 150 N

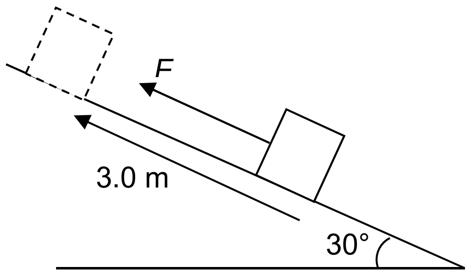
D 450 N

9 A bullet moving with a speed of 150 m s^{-1} strikes a wooden plank. After passing through the plank, its speed becomes 125 m s^{-1}. Another identical bullet strikes the plank with a speed of 90 m s^{-1}.

What is its speed after passing through the plank if the bullets experience the same constant retarding force in both cases?

A 25 m s^{-1} **B** 35 m s^{-1} **C** 50 m s^{-1} **D** 70 m s^{-1}

10 A force *F* of 80 N pulls an object of weight 40 N from rest up an incline of 30° through 3.0 m as shown below. The frictional force present is 30 N.



Which of the following correctly gives the heat generated due to friction and the gain in kinetic energy of the mass?

	heat / J	gain in kinetic energy / J
A	210	0
B	90	90
C	90	30
D	210	240

11 Two identical particles P and Q are set to travel in a circular path of the same radius. P moves in a vertical circle and Q moves in a horizontal circle. Both move with the same uniform speed.

Which of the following statements concerning the magnitude of the net force acting on P and Q towards the centre of the circular path is true?

A Both net forces on P and Q vary with time and are never equal in magnitude.

B Both net forces on P and Q vary with time and are equal in magnitude periodically.

C The net forces on P and Q are always equal in magnitude.

D The magnitude of the net force on P is always larger than that on Q.

12 A mass m_1 is attached to one end of an elastic string of an unstretched length L. When the mass is rotating with a linear speed v on a smooth table in a horizontal circle, an extension e is obtained.

Which of the following shows the correct expression for mass m_2, if it is rotated with the same linear speed v but rotates at twice the radius as that produced by m_1?

A $m_2 = \dfrac{2m_1(L+2e)}{e}$

B $m_2 = \dfrac{2m_1(L+e)}{e}$

C $m_2 = \dfrac{2m_1(2L+e)}{e}$

D $m_2 = \dfrac{2m_1(2L+2e)}{e}$

13 The gravitational force on an object at the top of Mount Fuji, with an elevation of 3776 m, is 40 N.

What would be the approximate gravitational force on the same object if it were taken to another mountain with twice the elevation?

A 10 N

B 20 N

C 30 N

D 40 N

14 The planet Venus has a mass 0.8 times that of Earth and a diameter 0.9 times that of Earth.

Taking the acceleration due to gravity at the Earth's surface to be $9.81\,\mathrm{m\,s^{-2}}$, what is the acceleration due to gravity at the surface of Venus?

A $8.7\ \mathrm{m\,s^{-2}}$

B $9.7\ \mathrm{m\,s^{-2}}$

C $17\ \mathrm{m\,s^{-2}}$

D $39\ \mathrm{m\,s^{-2}}$

15 Which one of the following statements about a simple harmonic oscillator is incorrect?

A The total energy of the oscillator is constant throughout the motion.

B The kinetic energy of the oscillator is maximum when it is at equilibrium position.

C The potential energy of the oscillator is zero when the oscillator is momentarily at rest.

D When the kinetic energy of the oscillator is equal to its potential energy, the oscillator is neither at the rest position nor at the maximum displacement positions.

16 In order to check the speed of a camera shutter, the camera was used to photograph the bob of a simple pendulum moving in front of a horizontal scale. The extreme positions of the bob were at 600 mm and 700 mm marks. The photograph showed that while the shutter was opened, the bob moved from 650 mm to 675 mm mark.

If the period of the pendulum was 2 s, how long does the shutter remain closed during the first 2 s of its motion?

A $\frac{1}{6}$ s

B $\frac{1}{2}$ s

C $1\frac{1}{2}$ s

D $1\frac{5}{6}$ s

17 An aluminium calorimeter of mass 0.05 kg contains 0.095 kg of a mixture of water and ice at 0 °C. When a 0.100 kg of aluminium block heated to 100.0 °C is dropped into the mixture, the temperature rises to 5.0 °C. The specific heat capacity of aluminium is 924 J kg^{-1} K^{-1}, specific heat capacity of water is 4200 J kg^{-1} K^{-1} and specific latent heat of fusion of ice is 3.36 x 10^{5} J kg^{-1}.

What is the mass of ice originally present in the mixture?

A 0.0195 kg

B 0.0202 kg

C 0.0254 kg

D 0.0261 kg

18 A cylinder contains a mixture of helium and argon gas in equilibrium at a temperature T.

Which of the following statements is correct about the mixture?

A Each gas molecule has the same translational kinetic energy.

B The gas molecules have the same root–mean–square speed.

C The argon gas molecules have greater kinetic energy compared with the helium gas molecules.

D Both types of gas molecules have the same mean translational kinetic energy.

19 Which of the following statements about the absolute scale of temperature is incorrect?

A It is based on two fixed points, namely the absolute zero of temperature and the triple point of water.

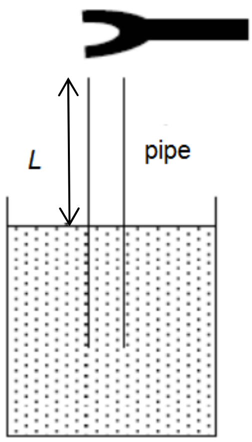
B The triple point of water is the one and only temperature at which water can exist in all three phases in equilibrium at the same time.

C The relationship between temperatures on the absolute temperature scale and temperature on the Celsius scale is given by T / K = θ / °C + 273.15.

D It depends on the property of the particular substance used to set it up.

20 A small pipe opened at both ends is partly submerged in water as shown below. A tuning fork vibrating at 850 Hz is placed over the top of the pipe. The pipe is slowly lifted until the first loud sound is heard when the length of pipe above water is *L*. The experiment is repeated with another tuning fork of unknown frequency *f* and the first loud sound is heard when the length of pipe above water is 2*L*.

Given that the speed of sound is 340 $\mathrm{m\,s^{-1}}$, what is the value of *f*?



A 213 Hz

B 425 Hz

C 1700 Hz

D 2550 Hz

21 A narrow beam of monochromatic light falls at normal incidence on a diffraction grating. The angle between the third order diffracted beam and the direction of the incident light is 40°.

What is the highest order of diffracted beam produced by this grating?

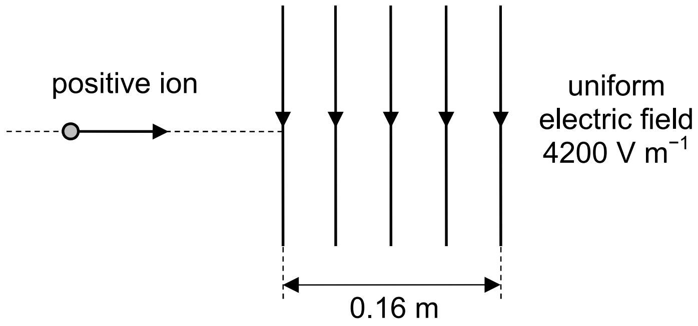
A 3^{rd}

B 4^{th}

C 5^{th}

D 6^{th}

22 An ion carrying a charge of $+4.8 \times 10^{-19}$ C travels horizontally at a speed of 8.0×10^{5} m s^{-1}, as shown below. It enters a uniform vertical electric field of strength 4200 V m^{-1}, which is directed downwards and acts over a distance of 0.16 m.



Which of the following statements is **not** correct?

A The ion passes through the field in 2.0×10^{-7} s.

B The force on the ion acts vertically downwards at all times in the field.

C The horizontal component of the velocity of the ion is unaffected by the electric field.

D The magnitude of the force exerted on the ion by the field is 1.6×10^{-9} N.

23 A positive charge of 2.6×10^{-8} C is placed in an electric field of constant field strength 300 kV m^{-1}.

How much work must be done on the charge in order to move it a distance of 4.0 mm in the same direction as that of the field?

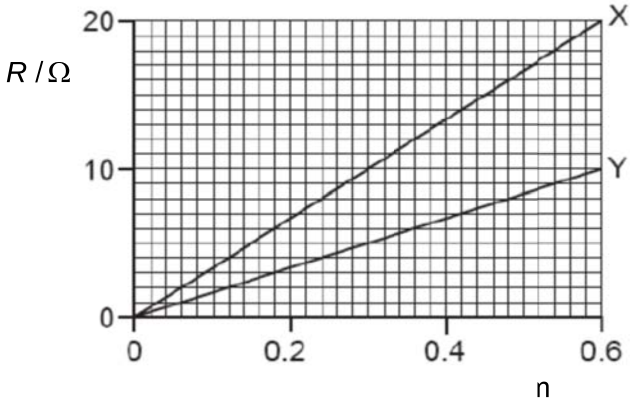
A 3.1×10^{-5} J

B -3.1×10^{-5} J

C 3.1×10^{-2} J

D -3.1×10^{-2} J

24 The graph shows the variation with length l of resistance R for two wires X and Y made from the same material.



Which of the following statements describes what the graph shows?

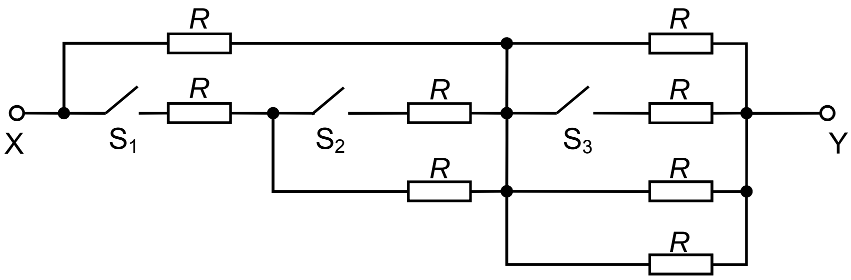
A when equal lengths of X and Y are connected in series to a battery, the power in X is twice the power of Y

B resistivity of X is twice the resistivity of Y

C when equal lengths of X and Y are connected in parallel to a battery, current in X is twice the current of Y

D cross-sectional area of X is twice the cross-sectional area of Y

25 A network is constructed using eight resistors, each of resistance R, and three switches S_1, S_2 and S_3.



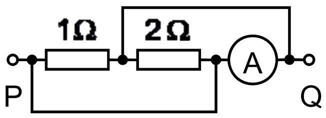
Which switch combination will give rise to the maximum total resistance between points X and Y?

	S_1	S_2	S_3
A	closed	closed	closed
B	closed	open	closed
C	open	closed	closed
D	open	open	open

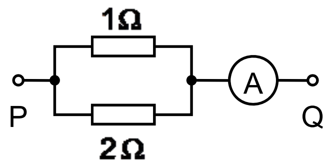
26 In each arrangement of resistors below, the ammeter has a resistance of $2\,\Omega$.

Which arrangement gives the largest reading on the ammeter when the same potential difference is applied between points P and Q?

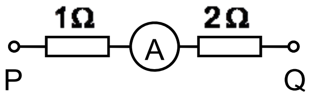
A



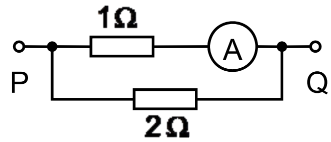
B



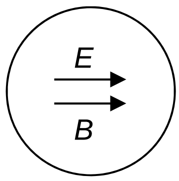
C



D



27 In a cathode-ray oscilloscope tube, the electron beam passes through a region where there are electric and magnetic fields directed horizontally rightwards as shown.

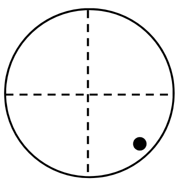


front view of screen

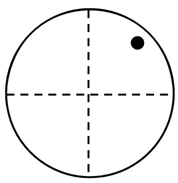
The deflections of the spot from the centre of the screen produced by the electric field *E* and magnetic field *B* separately are equal in magnitude.

Which diagram shows a possible position of the spot on the screen when both fields are operating together?

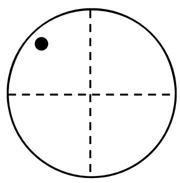
A



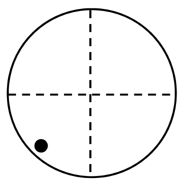
B



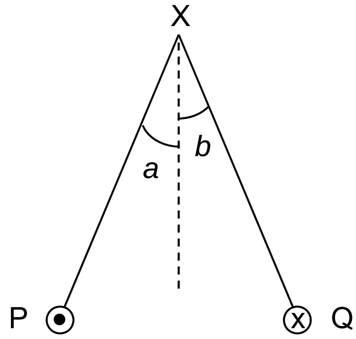
C



D



28 Two identical long straight aluminium wires P and Q carry the same current but in opposite directions. They are suspended by identical fine nylon threads from a fixed point X. It is found that, in equilibrium, the angle *a* is the same as the angle *b*.



If the current in P is increased to twice its original value, which one of the following statements about the angles *a* and *b* is correct?

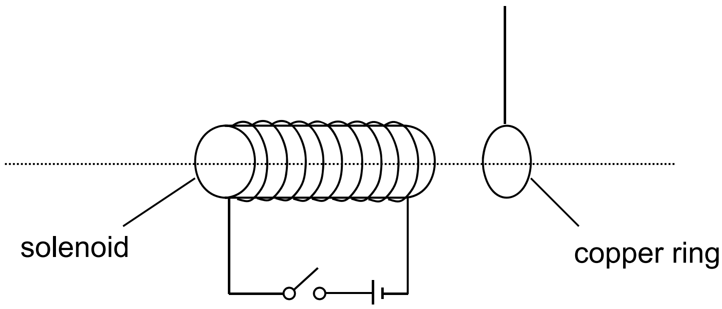
A $a = \frac{1}{2}b$

B $a = b$

C $a = \sqrt{2}b$

D $a = 2b$

29 A solenoid is connected in series with a battery and a switch as shown. A light, copper ring is held near to the solenoid and coaxial with it.



What will happen to the copper ring immediately after the switch is closed?

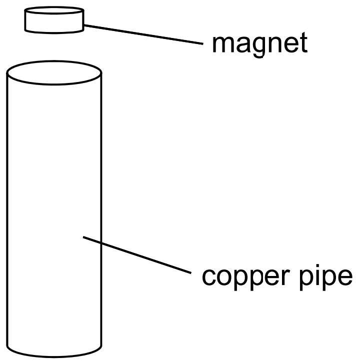
A The ring remains stationary.

B The ring swings directly away from the solenoid.

C The ring swings directly towards the solenoid.

D The ring rotates about its vertical axis.

30 When a small cylindrical magnet is released from rest above a copper pipe, the magnet falls slowly through the pipe.



Which of the following can be made so that the magnet falls slower through the same length of the pipe?

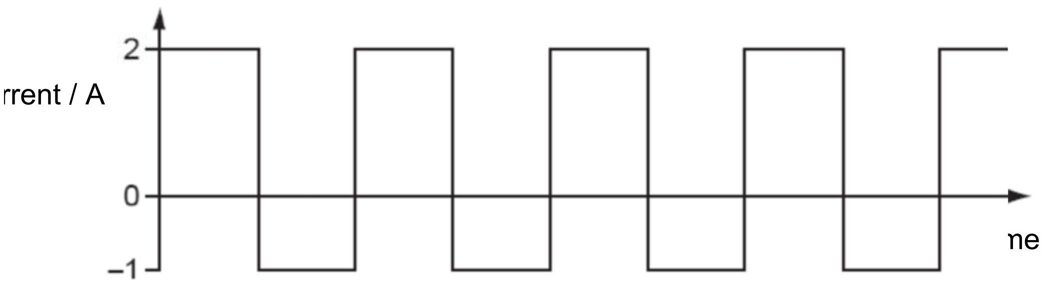
A Place the magnet nearer to the top of the pipe before releasing it from rest.

B Use a pipe of material with higher resistivity.

C Use a weaker magnet of the same mass.

D Use a lighter magnet.

31 A 100 Ω resistor conducts a current with changing direction and magnitude, as shown.



What is the mean power dissipated in the resistor?

A 100 W

B 150 W

C 250 W

D 400 W

32 A transformer has 1200 turns on the primary coil and 500 turns on the secondary coil. The primary coil draws a current of 0.25 A from a 240 V ac supply.

If the efficiency of the transformer is 83 %, what is the current in the secondary coil?

A 0.10 A

B 0.21 A

C 0.50 A

D 0.60 A

33 A metal surface in an evacuated tube is illuminated with monochromatic light causing the emission of photoelectrons which are collected at an adjacent electrode. The experiment is to be repeated with light of half the intensity but the same wavelength.

How will the photocurrent I and stopping potential V be affected?

A I unchanged and V unchanged

B I unchanged and V halved

C I halved and V unchanged

D I halved and V halved

34 A photon of light enters a block of glass after travelling through a vacuum. The energy of the photon on entering the glass block

A increases because its associated wavelength decreases.

B stays the same because the speed of the radiation and the associated wavelength do not change.

C stays the same because the frequency of the radiation does not change.

D decreases because the speed of the radiation decreases.

35 The accelerating potential difference in an X-ray tube is 20 kV.

What is the shortest wavelength of the X-ray photon emitted from the X-ray tube?

A 6.22×10^{-11} m

B 6.22×10^{-10} m

C 1.61×10^{-11} m

D 1.61×10^{-10} m

36 Energy levels in low-pressure gases are represented as lines whereas in solids, the levels are shown as bands.

What is responsible for the formation of bands?

A Solids are better electrical conductors than gases.

B Solids are not fluids but gases are fluids.

C Atoms in solids are much denser than those in gases.

D Atoms in solids are much closer together than those in gases.

37 Which statement about the energy bands in an ideal intrinsic semiconductor is correct?

A The conduction band lies just below the valence band.

B The number of electrons in the conduction band equals the number of holes in the valence band.

C There is an energy gap of 5 eV to 10 eV between the valence and conduction band.

D There is a small overlap between the valence and conduction band.

38 Which of the following statements about laser is false?

A An external energy source is needed to create population inversion.

B The laser beam produced is coherent and of a single wavelength.

C By using a partially reflecting mirror which reflects light more efficiently, the intensity of the laser beam produced is increased.

D Laser systems produce beams that would not spread out.

39 The equation $^{235}_{92}U + ^{1}_{0}n \rightarrow ^{121}_{45}Rh + ^{113}_{47}Ag + 2^{1}_{0}n$ shows the fission of a Uranium-235 nuclide by a slow moving neutron into a Rhodium-121 nuclide, a Silver-113 nuclide and two neutrons.

binding energy per nucleon of $^{235}_{92}U = 7.59$ MeV

binding energy per nucleon of $^{121}_{45}Rh = 8.26$ MeV

binding energy per nucleon of $^{113}_{47}Ag = 8.52$ MeV

What is the energy released during this fission process?

A 9.19 MeV

B 24.4 MeV

C 73.9 MeV

D 179 MeV

40 A parent nucleus, initially at rest, decays into two particles of masses m_1 and m_2, moving away from each other in opposite directions.

If E is the total energy of the two particles, what is the energy associated with the particle of mass m_1?

A $\frac{m_1}{m_2}E$

B $\frac{m_2}{m_1}E$

C $\frac{m_2}{m_1 + m_2}E$

D $\frac{m_1}{m_1 + m_2}E$

End of paper