![Haileybury logo]

Name	
Current School	

Physics

Entrance exam for: 16+ (Sample)
Time allowed: 45 minutes
Total marks: 30

Please read this information before the examination starts

- Attempt **any 15 questions**

- Write your answers in the spaces provided on the question paper
- You may use a calculator
- Quote any formulae you use and show all relevant working
- Include units with numerical answers, where appropriate
- The strength of the Earth's gravitational field at its surface, *g*, can be taken as 10 N/kg

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For office use only

Marks awarded:	
Comments:	

Section 1: Forces and motion

Velocity-time graph
1) A and B are two points on a straight road. A car travelling along the road passes through A when t = 0 and maintains a constant speed until t = 30 seconds and in this time covers three fifths of the distance from A to B. The car then retards uniformly to rest at B.
a) Sketch a velocity-time graph for the motion

b) Find the total time taken for the car to travel from A to B.

Mechanical power and energy

2) A pump lifts 120 m^3 of water per hour from a reservoir to a point 4.0 m above the reservoir water level. It discharges the water at this level with a velocity of 7.0 m/s. What is the power that has to be supplied to the pump if it has an efficiency of 60% (density of water = 1000 kg m^{-3})?

Conservation of momentum

3) A railway truck of mass 1800 kg moving at 4.0 m/s collides with a truck of mass 1200 kg moving in the same direction at 3.0 m/s. If they join and move on together, what is their combined velocity just after the collision?

Impulse

4) A ball having a mass of 100 g has a velocity of 30 m/s when a bat hits it. After the collision, the ball reverses its direction of motion and has a velocity of 50 m/s. If the ball is in contact with the bat for 4.0 ms (milliseconds).
What was the average force acting on the ball?

Section 2: Electricity

Accelerating charge

5) A mercury atom which has a mass 2.2×10^{-25} kg, has lost two electrons (each electron has a charge of 1.6×10^{-19} C). What will be its speed if it is accelerated from rest by a potential difference of 1.8×10^3 V? Assume that the mass of the electrons is negligible compared to the mass of the atoms).

Electrical circuit

6) Calculate the value of the resistance, R in the electrical circuit shown in figure 1.
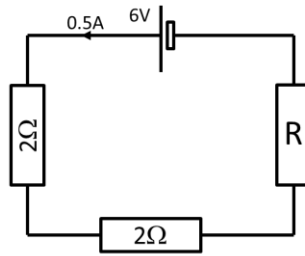

Figure 1

Total resistance of a combination of resistors

7) Calculate the total resistance of the following array of resistors, shown in figure 2:
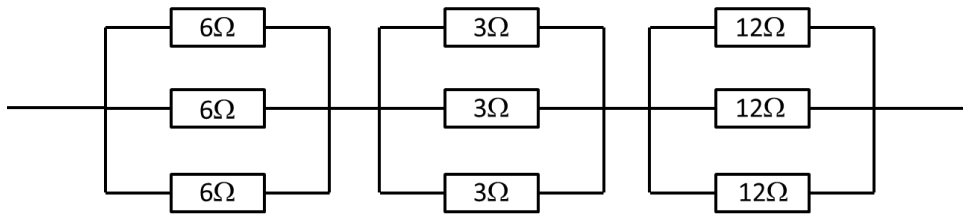

Figure 2

Resistors in parallel

8) What resistor must be connected in parallel with a 60 Ω resistor to give a total effective resistance of 36 Ω?

Electrical power

9) The power of the heater element of a toilet hand dryer is 2100 W. It is used by 100 people per day. If each person uses it for an average of 3 minutes, how much energy does the hand dryer use in a week?

Section 3: Waves

Refractive index and critical angle

10) Water has a refractive index of 4/3 for light passing into it from air.

(a) For an angle of incidence of 30° what is the angle of refraction?

(b) What is the critical angle for light passing from water into air?

Sound waves

11) A gun fires a shell of average velocity 400 m/s, at a fort 4000 m away. What time elapses between the shell reaching the fort and the men in the fort hearing the sound of the gun being fired? [Assume that the speed of sound in air is 330 m/s]

Section 4: Energy resources and energy transfers

Energy conversion

12) An object is thrown vertically upwards with an initial speed of 10 m/s. What is the maximum height from reached by the object from the launch position?

Efficiency

13) A device is 40% efficient and dissipates energy as heat. The device dissipates 240J of thermal energy over a period of 2 minutes.   What is the input power of the device?

Section 5: Solids, liquids and gases
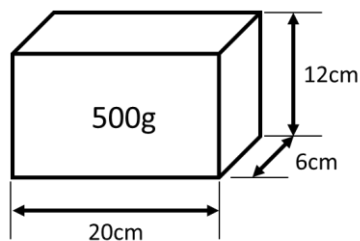
Mixing hot and cold water
14) Find the final temperature when a mass of 80g of water at 100 °C is mixed with a mass of 40 g of water at 25 °C.

Mass of an atom
15) What is the mass of 1 atom of C-12? [The Avogadro constant is 6.02×10^{23}].

Pressure exerted by a cuboid
16) A cuboid has the dimensions of 6cm×12cm×20cm and a mass of 500g.

Calculate the least pressure that the cuboid can exert when resting with one face on the surface of a table. [Take the acceleration due to gravity as g=10 N/kg]

Gas pressure

17) With reference to the motion of molecules, explain how a gas exerts a pressure on the walls of a container. Include any equations that are relevant to the explanation.

Section 6: Magnetism and electromagnetism

A transformer

18) A step-up transformer operating on a 24 V supply provides energy at 240 V. If the efficiency is 80 %, find the current in the primary when the secondary is connected to a 240 V, 60 W lamp.

Section 7: Radioactivity and particles

Radioactive decay

19) A radioactive counting system records a count of 3250 Bq for a particular radioactive source at 10.00 a.m. on Monday. If the background reading is 50 Bq and the half-life of the source is 9 hrs, what will the count rate for the sample be at 1.00 p.m. on the next day?

Decay series

20) Radioactive decay series involve the emission of various nuclear radiations and corresponding changes in the mass number A and atomic number Z of the parent nucleus. Complete the following table:

First member of series	Particles emitted in course of series	Final member of series	
Uranium $^{238}_{92}U$	8α and 6β	**A =**	**Z =**

Section 8: Astrophysics

Orbital motion

21) The moon has a period of 27.5 days round the Earth. What is its velocity in km per hour, assuming it moves uniformly in a circular orbit of radius 3.8×10^8 m?

The Doppler Effect
22) A helium sample in a laboratory emits light which has a wavelength of 370.5 nm. The same light emitted by a star in a distant galaxy has a wavelength of 390.0 nm. Calculate the speed of recession of the galaxy from Earth.

Section 9: Units

Units of angle
23) An angle can be measured in radian (rad) or degree (°). An angle of 360° is equal to 2π radian. A degree can be split into 60 arc minutes (1° = 60'). An arc minute can be split into 60 arc seconds (1' = 60''). [Assume that π=3.142]

a) Convert the angle 42°30'50'' into radian

b) Convert the angle of 2.6 radian into degree, arc minute and arc second.

Different unit conversions

24) Convert the following units:

(a) A speed of 72 km/h into m/s.

(b) A density of 72 kg/m^3 into g/cm^3.

(c) A volume of 4 m^3 into mm^3.