This mark scheme is published as an aid to teachers and candidates, to indicate the requirements of the examination. It shows the basis on which Examiners were instructed to award marks. It does not indicate the details of the discussions that took place at an Examiners’ meeting before marking began, which would have considered the acceptability of alternative answers.

Mark schemes should be read in conjunction with the question paper and the Principal Examiner Report for Teachers.

Cambridge will not enter into discussions about these mark schemes.

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1 (a) (i) 60 m B1
(ii) 12 s B1
(b) (i) straight line from origin to 200 m at 40 s B1
any line straight or curved from (40,200) to (60,500) B1
(ii) \[ s = \frac{d}{t} \text{ or } 500/60 \] C1
8.3 m/s A1

2 (a) (i) force moves through a distance (in same direction) B1
(ii) chemical (potential) energy B1

(b) (i) 480 Nm B1
(ii) attempt to apply moments with two forces and distances 400 N C1
400 N A1

3 (a) Pa or \( \frac{N}{m^2} \) or cm of mercury or atmosphere(s) B1

(b) correct points plotted at \((0.5V_0, 2P_0)\) and \((2V_0, 0.5P_0)\) B1
curve through points of decreasing gradient B1

(c) molecules hit sides/piston B1
more molecules hit per second/hit more frequently B1
molecular impacts create large(r) force (upwards on piston) B1

4 (a) oscillate/vibrate stated or described B1
transverse movement described B1

(b) 0.40 m B1

(c) (i) \( v = f \lambda \) or \( f = \frac{v}{\lambda} \) or \( 2l/b \) C1
5.0 Hz A1
(ii) clear attempt to draw wave moved along 0.20 m to right B1

5 (a) \( \sin i / \sin r \) or \( \sin 50 / \sin 30 \) C1
1.5(321) A1
(b) moving from more dense to less dense medium or moving to lower refractive index (air)
angle of incidence is greater than critical angle

(c) less heat loss / more efficient
less chance of hacking / more secure / less interference
less reduction in signal / less need for boosting / larger distances possible / thinner or less bulky

6  (a)  (i) \( I = \frac{V}{R} \) or \( \frac{6}{60} \) C1
0.1(0) A A1

(ii) \( I = \frac{P}{V} \) or \( \frac{0.9}{6} \) C1
or 0.15 (A) seen
0.25 A A1

(b) (i) lamp correctly drawn in series with resistor but not the lamp

(ii) less voltage (across lamp) because some voltage across resistor / shares voltage with resistor or less current because of effect of resistor

7  (a) field lines of magnet mentioned or magnetic flux mentioned B1
field lines cut the coil or flux changes B1

(b) reversed movement of magnet causes one of
- reversal of (induced) emf
- reversal of (induced) current
- field lines cut / flux change in reverse direction
LED emits light when current passes in one direction

(c) more current or more induced emf and flux lines cut faster or faster change in flux

8  (a) emission of electrons B1
emission caused by heat / high temperature B1

(b) anode positive B1
anode attracts / accelerates electrons B1
or electric field between filament and anode

(c) two sets of plates shown at 90º to each other with connection(s) labelled y plates and x plates / time base B1
9 (a) (i) speed and mass  

(ii) 1 speed and direction  

or distance/time and direction  

or displacement/time  

2 direction changes  

(iii) force of gravity from/towards Earth  

force is centripetal  

or at right angles to motion/velocity  

(b) (i) 450 000 N  

(ii) \( (a =) \frac{F}{m} \) or 50 000/40 000  

1.25 m/s²  

(c) (i) same change in velocity/speed  

in same time period  

(ii) start at origin and straight line for first 4 minutes  

gradient increases at first after 4 and then decreases  

constant speed from 10 minutes until 12 minutes  

(iii) area under graph  

10 (a) (liquid) molecules not arranged (so) regularly  

(liquid) molecules not vibrating/moving in same direction  

or do not have same speed  

(b) (i) molecules/liquid escape (from surface)/break bonds  

(ii) fast moving/more energetic molecules evaporate/escape  

leaving slow molecules or molecules with less kinetic energy (on average)  

(c) (i) hot air rises  

(ii) (steam) condenses or changes to liquid (on thermometer)  

or heat (conducted) from hot to cold  

gives out latent heat (to thermometer)  

or explanation involving bonds being made
11

(a) (i) 51

(ii) more protons than electrons
or different number of protons and electrons positive and negative do not cancel

(iii) 25 protons
a different number of neutrons

(b) (i) 147

(ii) $\alpha$ has mass number 4
$\alpha$ has proton number 2
correct proton number for U ecf their value for $\alpha$

(c) (i) alpha particles only travel a short distance in air
or alpha particles stopped/scattered/deflected by air
or alpha particles ionise air

(ii) particles come off in different directions
or not emitted in one line/as a ray
or not all the particles pass through the slit

(iii) B correct shape and deflected more than A

(iv) particles close to/fired at the nucleus are deflected (back)/repelled
some particles pass (straight) through
a few particles come back/large deflection or most pass (straight) through
(with little deviation)
and how this explains the nucleus is small